CIVIL ENGINEERING

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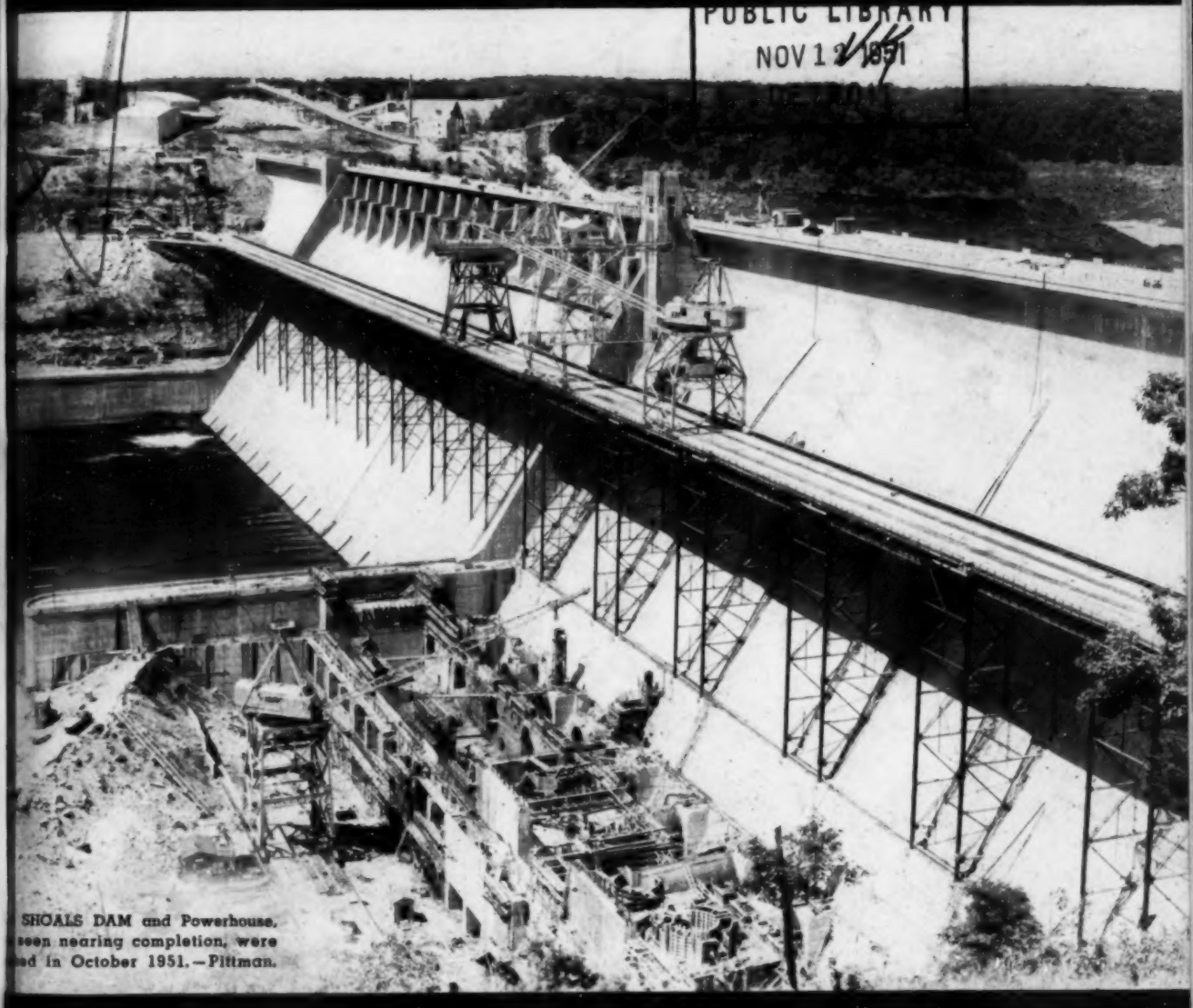


SHOALS DAM and Powerhouse,
seen nearing completion, were
ed in October 1951.—Pittman.

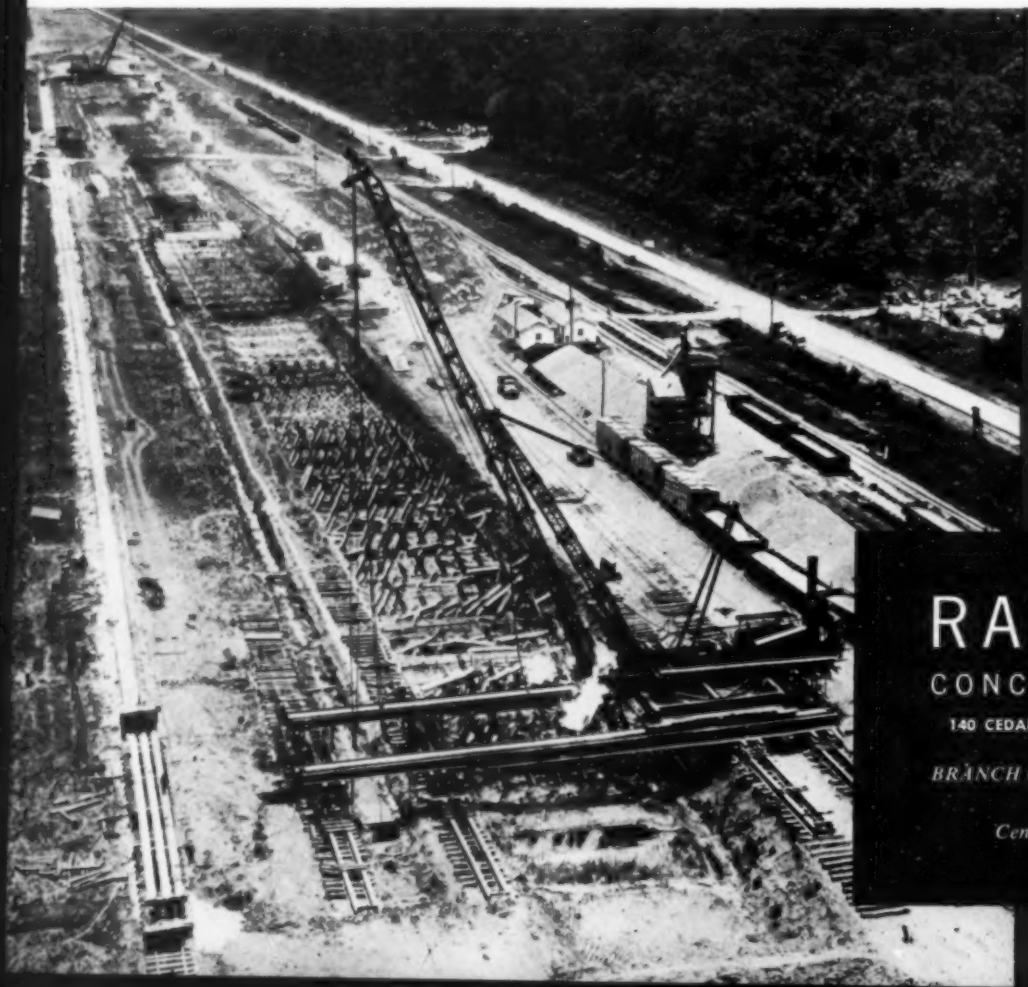
GIANT MORGANZA FLOOD CONTROL JOB

COMPLETED 3 MONTHS AHEAD OF SCHEDULE!

DRIVING FOUNDATION PILES for the gated portion of Morganza, La., Floodway Control Structure is one of the outstanding pile jobs of the year. Skilled planning of operations and use of two of the largest pile drivers ever built have enabled Raymond to complete this work three months ahead of schedule. Structure is supported on 3,734 precast concrete piles 80 to 118 feet in length—practically all driven on a batter.

AROUND THE WORLD · FOUNDED 1897

Design and Construction under Supervision of
COL. CHARLES E. HOLLE, U.S.A., *District Engineer,*
New Orleans District, Corps of Engineers
Department of the Army.



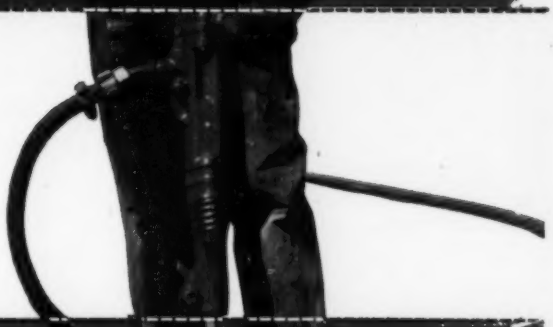
THE SCOPE OF RAYMOND'S ACTIVITIES . . .

Soil Investigations, Piles and Caisson Foundations, Underpinning, Harbor and River Improvements and Lining of Steel and Concrete Pipelines by the Centriline and Tele Processes.

RAYMOND
CONCRETE PILE CO.
140 CEDAR STREET • NEW YORK 6, N. Y.

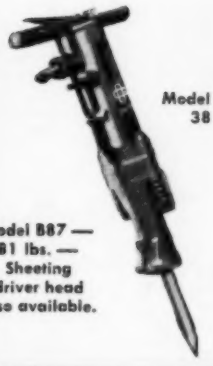
BRANCH OFFICES in the Principal Cities of United States and Central and South America.

SHORT
WHERE IT COUNTS
...LONG
ON QUALITY



Model B67 — 63 lbs.

Model B37 — 38 lbs.



Model B87 — 81 lbs. — Sheeting driver head also available.

New Sump Pump Dependability

The VP4 Sump Pump is designed on a new principle of *Top-Suction* — won't bury itself in a muddy sump. Top-Suction also pulls gritty water away from the shaft seal — protects the seal, shaft and motor from wear — sharply reduces maintenance. "One-shot" lubrication oils entire pump for 24 hours of service.

Shorter from tool-top to handle, Gardner-Denver Paving Breakers are easier to hold! Your men move about the job faster and safer, too — thanks to the exclusive Gardner-Denver safety latch that works like the safety on a gun.

And here are some of the quality *extras* that make these breakers powerful "busters" on your demolition jobs:

Automatic short throw valve — virtually unaffected by wear.

Non-freezing exhaust — maintains top efficiency on cold, damp days.

Renewable chuck liner — protects both tool and breaker against loose-fitting shank.

Integral oil reservoir — insures proper lubrication to all working parts.

SINCE 1859

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

CIVIL ENGINEERING, The Magazine of Engineered Construction, November, 1951. Vol. 21, No. 11. Published monthly by the American Society of Civil Engineers. Publication office 20th and Northampton Streets, Easton, Pa. Editorial and advertising departments at the headquarters of the Society, 33 West 39th Street, New York, N. Y. Price 50¢ a copy, $5.00 a year in advance, $4.00 a year to members and to libraries and $2.50 a year to members of Student Chapters. Canadian postage 75¢ and foreign postage $1.50 additional. Entered as second class matter September 23, 1930, at the Post Office, Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

what can't Aerial Mapping do?

It's Saving Lots of Time and Money for Busy Engineers in Many New Ways . . .

Newest of A.E.C. Facilities at Aiken, S. C.

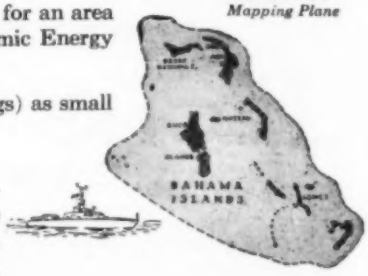
Here's how and where:

Busy engineers—now pressed for time and manpower—find air mapping can do many jobs for them . . . quickly, economically, dependably.

AERO mapping can produce topographic maps for an area 210,000 acres big in 160 days (for a new Atomic Energy facility).

Or—it can tally a stockpile (coal, minerals, logs) as small as 6 acres.

Shoran Guides Mapping Plane



It can map a whole vast area (83,000 square miles in the Bahamas, for instance) where no landmarks exist—and guide the mapping plane with the new positioning device, Shoran. Similarly, it can cover the trackless jungle.

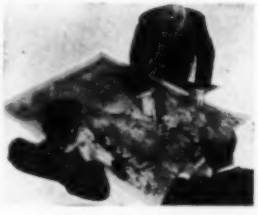
It delivers resource inventories for big areas (such as Portuguese East Africa, western Canada) . . . development mapping (Middle East, Minnesota) . . . and produces highway design and location maps (for instance, New York, Washington, Virginia) in a fraction of the time of plane table surveys.

Checking Resource Inventory Data

Penna. Turnpike Location Map

Lower Manhattan Seen from the Air

It maps cities (New York, Durham, North Carolina, Eastlake, Ohio and others) for Civil Defense and city planning; it makes timber tallies (Canada, Louisiana, Maine); it produces geologic studies (Pennsylvania, Wyoming, Venezuela, Tunisia, Union of South Africa) for oil and mining companies. It locates railroads, power lines, pipe lines, (Alaska, Minnesota, Maryland).



Photomap and Aeromagnetics Aid Geologic Study

AERO is doing all of these things!

If you are planning for the mapping of any large area, let AERO's photogrammetric engineers bring 32 years of world-wide mapping experience to your conference table. They know air mapping's applications; they understand engineering problems. They are a part of a 300-man organization whose business is working with engineers to produce dependable maps for specific engineering problems.

AERO ***can fulfill all your mapping requirements . . . usually at half the cost and time of ground surveys.*** **Write AERO today.**

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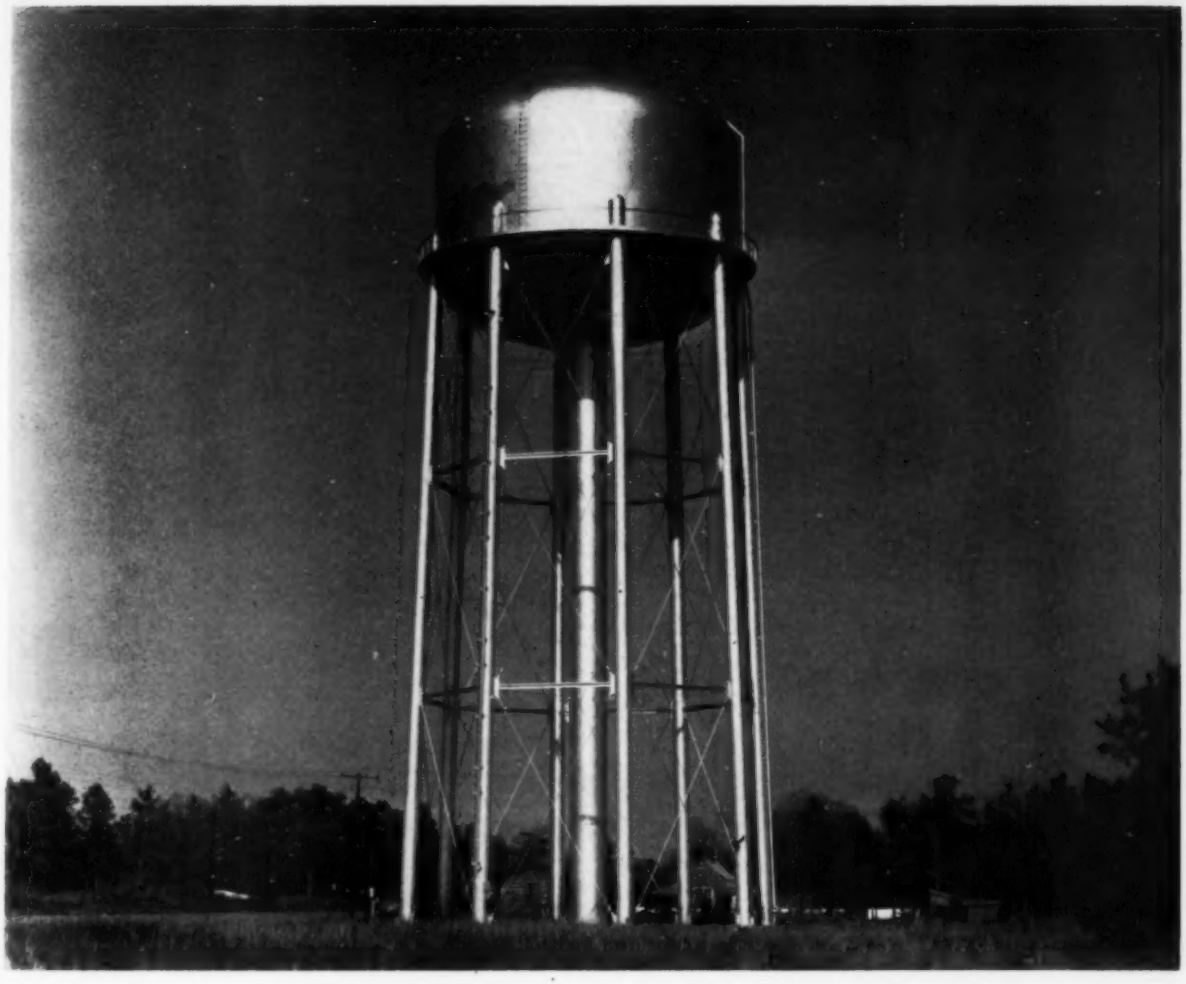

Better Water Service for 7,250 Texans

To provide better municipal water service for its 7,250 population, Conroe, Texas, recently installed the Horton ellipsoidal-bottom elevated tank shown above.

Conroe, seat of Montgomery County, covers an area of three square miles and obtains its water from three deep wells near the center of the city. The new 500,000-gallon tank serves the entire city through over 7,000 feet of transmission and distribution mains. Average daily water consumption is about 1,000,000 gallons.

Before this Horton tank was put into service, water pressures were sometimes as low as 35 lbs. per sq. in. Now all-over pressure is maintained at a uniform 65 lbs. per sq. in. Operating costs have been reduced as the tank is filled during early morning hours when power rates are lower. Also, with the installation of their Horton elevated tank and additional fire equipment and hydrants, Conroe obtained a better insurance classification. This has resulted in substantially lower insurance premiums.

These modern, highly efficient structures are the symbol of better water service for hundreds of metropolitan cities or rural villages. And their use is not limited to any particular size of municipality. Whether your community is large or small, you can benefit in many ways with Horton elevated storage. Follow the example of Conroe, Texas, and of hundreds of other cities that have successfully met their water service problems with Horton elevated water tanks. Horton ellipsoidal-bottom elevated tanks are built in standard capacities from 15,000 to 500,000 gallons. Larger elevated tanks of radial-cone or Hortonspheroidal design are built in capacities up to 3,000,000 gallons.

For more information, write our nearest office giving type of service, location, and height to bottom.

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Atlanta 3.....2167 Healy Bldg.
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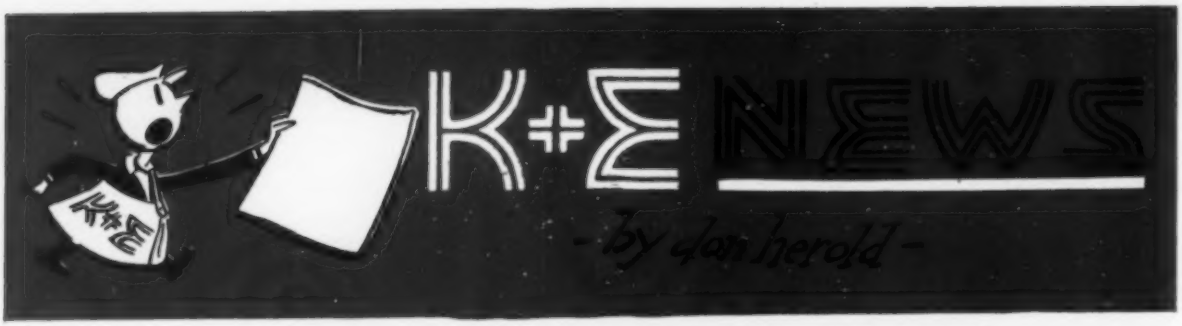
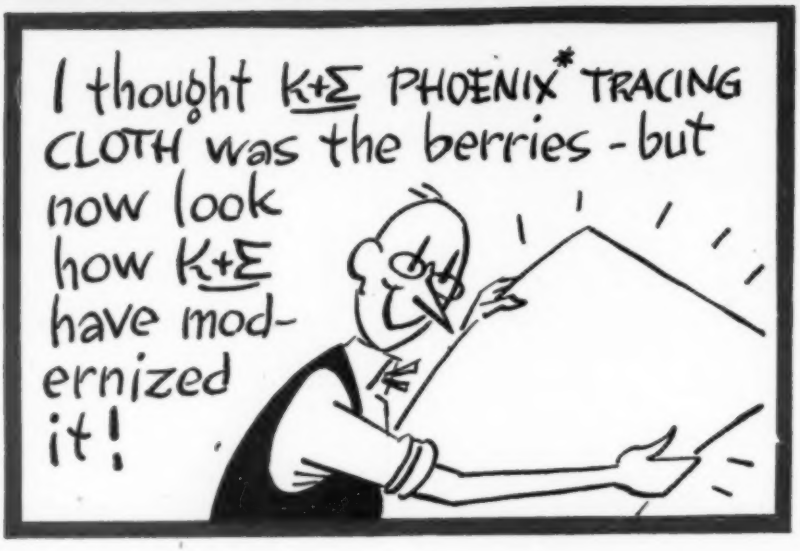
Cleveland 15.....2263 Guildhall Bldg.
Detroit 26.....1541 Lafayette Bldg.
Houston 2....2128 National Standard Bldg.
Los Angeles 17..1556 General Petroleum Bldg.
New York 6.... 3395—165 Broadway Bldg.
Philadelphia 3..1652—1700 Walnut St. Bldg.
Salt Lake City 4...509 West 17th South St
San Francisco 4.....1584—200 Bush St
Seattle 1.....1309 Henry Bldg
Tulsa 3.....1647 Hunt Bldg.
Washington 6, D.C.....1156 Cafritz Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.





how good can a tracing cloth get!

PHOENIX* Tracing Cloth always did feel good to an engineer's pencil, but, now, new improved N166 PHOENIX feels better than ever—performs better—is better. It's whiter than ever—which gives it better contrast for pencil line drawings. (This helps reprint transparency.)

The new PHOENIX is toughened to take today's new vigorous printing techniques—repeated trips under higher powered lights or through hotter printing machines.

The new N166 thrives under an ultra-violet test, which equals thousands of prints on a machine, or years of exposure to daylight. No appreciable yellowing.

Improved PHOENIX resists heat of glass cylinders even as high as 250° to 275°. Will not stick.

K&E have also given this cloth a Bureau of Standards three day 212° heat test, which is the equivalent of years of aging. It retains its whiteness remarkably well.

The new PHOENIX resists ammonia vapors and discoloration by contact with diazo prints in storage.

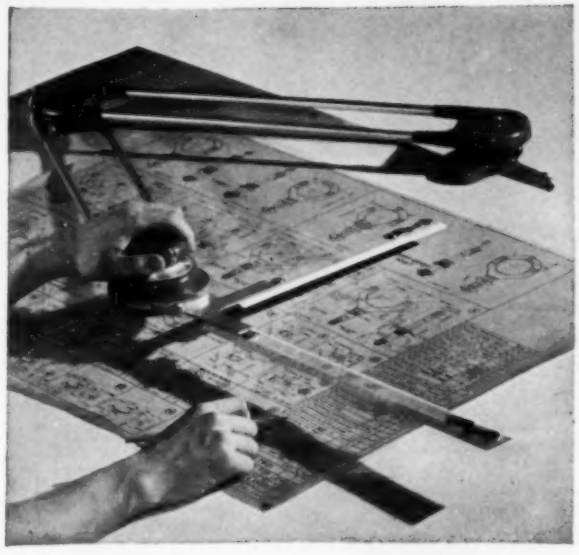
Its surface takes friction heat of motor erasers without softening or stain.

2-way water resistant

Both sides of the new PHOENIX are wonderfully water-resistant. This is important, since, if one side is more water-resistant than the other, the weaker side runs the show. By water, I mean water AND perspiration.

Gosh, I never dreamed I could say so many exciting things about a piece of cloth!

*Trade Mark ®

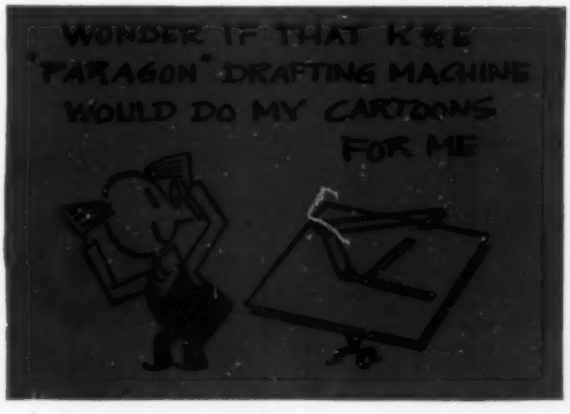


it's twice as fast as "human" drawing

You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.



Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

†Trade Mark

this whee-e-eraser saves time and elbow grease

This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.

Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice —60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

*Trade Mark

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

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The Rittenhouse-Claridge

Twenty-five story, 482-family Rittenhouse-Claridge apartment building, Philadelphia. *Owners:* M. H. McCloskey and Kevy K. Kaiserman, Philadelphia; *Builders:* McCloskey & Co., Philadelphia; *Architects:* J. Raymond Knopf, Samuel I. Oshiver, J. Ethan Fieldstein, Philadelphia; *Structural Engineer:* Robert E. McLaughlin, Philadelphia; *Mechanical Engineer:* Leslie S. Tarleton, Philadelphia.

This imposing 25-story apartment building, rapidly nearing completion in the heart of Philadelphia, occupies a 160 ft x 160 ft tract, and faces fashionable Rittenhouse Square.

The 1500-room Rittenhouse-Claridge will be fully air conditioned, and its apartment units, ranging in size from 1½ to 7½ rooms, will accommodate 482 families. Its facilities include two terrace apartments, a restaurant, and a basement garage for 125 automobiles. A 200-ft radio tower, plus a 50-ft pylon, will grace the top of the structure. The exterior is buff Roman-style brick, with terra-cotta trim at the first-floor level. Exterior columns are set back to permit the use of continuous metal sash with casement windows.

The 3000 tons of steel in the framework of the Rittenhouse-Claridge were fabricated and erected by Bethlehem.

BETHLEHEM STEEL

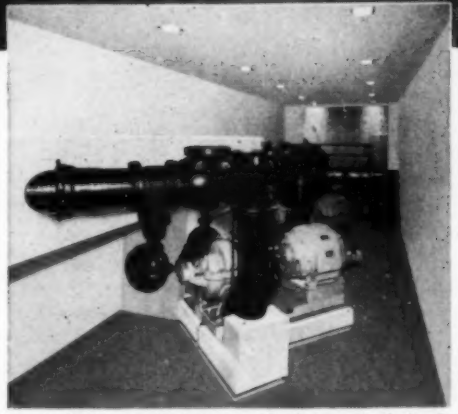
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

FABRICATED STEEL CONSTRUCTION

Now...Dallas Park Cities *are pumping with Economy!*

Portion of main pump room, Park Cities Water Treatment Project. Shown are 13 of the 22 Economy Pumps installed on this project.



View in University Park Booster Station, part of the Park Cities project. These Economy Pumps boost the pressure going to the overhead storage tank, located 5 miles from the treatment plant.

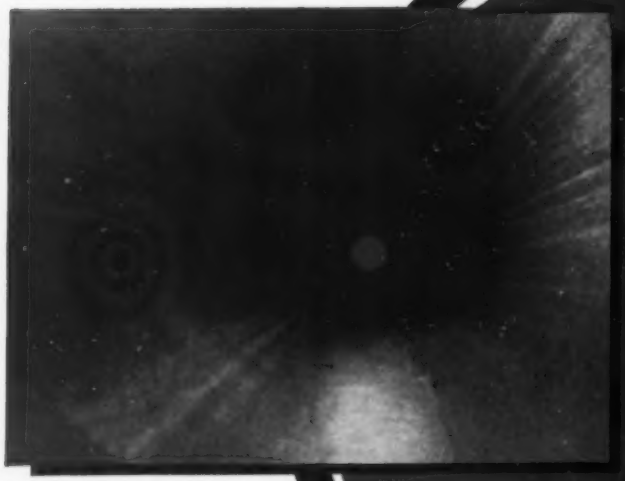
in new Park Cities, Texas, Water Treatment Plant

Economical operation over a period of years was a primary requisite of the pumps for Park Cities Water Treatment Project, Dallas. In selecting pumps, Powell & Powell, Consulting Engineers, drew up specifications which took into consideration cost of equipment, efficiency of each unit and efficiency of units operating in series, plus rigid structural requirements and refinements of mechanical detail. Under this very exacting evaluation formula, Economy Pumps, designed especially for water works service, supplied by the Lone Star Pump and Machinery Co., were selected, on the Dallas County project.

It pays to specify Economy Pumps for water supply. For detailed information and illustrated catalogs write today to Dept. BK-11.

Economy Pumps, Inc.

SEDGLEY AVE., AT 19th AND LEHIGH, PHILADELPHIA 32, PA.



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- Protect against corrosion.
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Are you encountering leaks, reduced flow capacity or other pipe line troubles due to failure in service of an old pipe line?

If so, reconditioning by the famous TATE and CENTRILINE processes can solve your problems quickly, efficiently and economically.

These processes use patented equipment that thoroughly removes all tuberculation and incrustation and applies a smooth, continuous cement mortar lining of proper thickness. All the work is done with the pipe line in place and with only momentary interruption of service to install by-pass lines.

The thoroughly reconditioned pipe gives practically new and permanent pipe line performance at much less than new pipe line costs. Write for complete details today.

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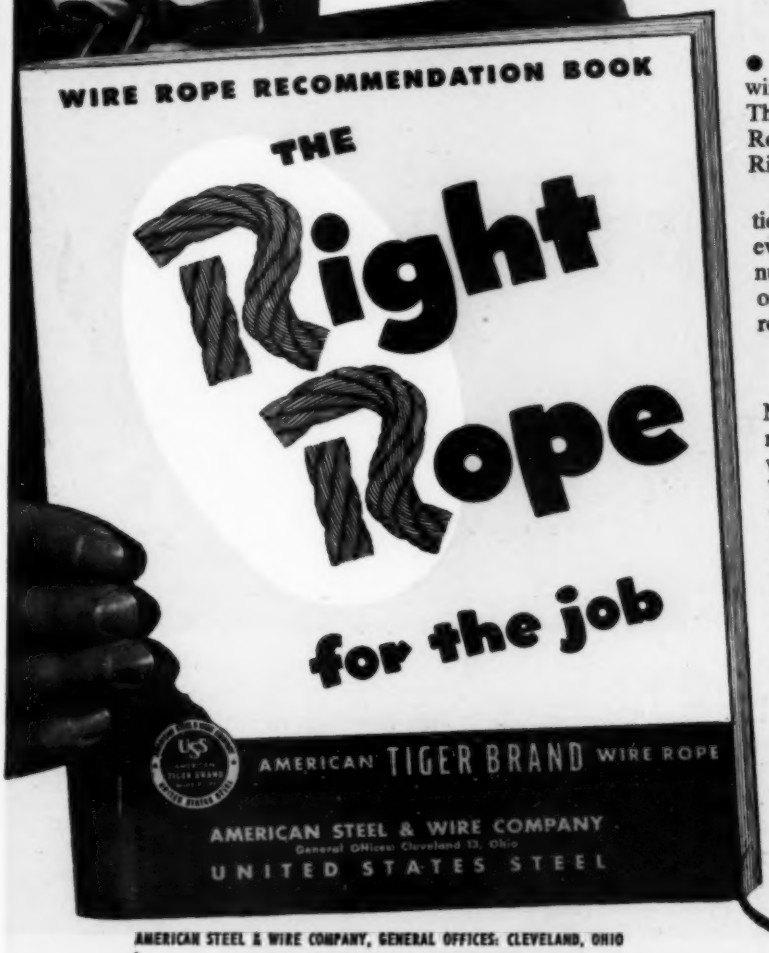
This New Book can save plenty of money for YOU!

IT SHOWS YOU HOW TO BE A BETTER BUYER OF WIRE ROPE



● Here is a book that every user of wire rope should have in his file—The American Tiger Brand Wire Rope Recommendation Book, "The Right Rope for the Job."

It covers all industries—construction, mining, petroleum, marine—even aircraft control cable. There are numerous photographs, plus listings of equipment and the types of wire rope that should be used.

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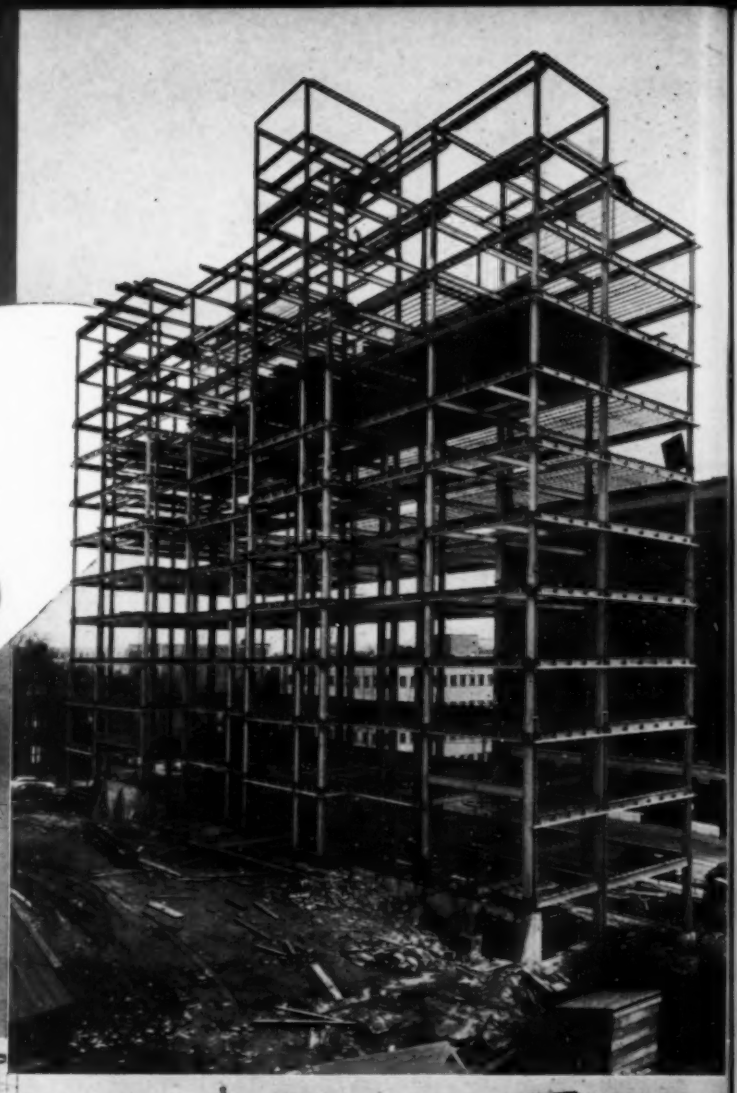

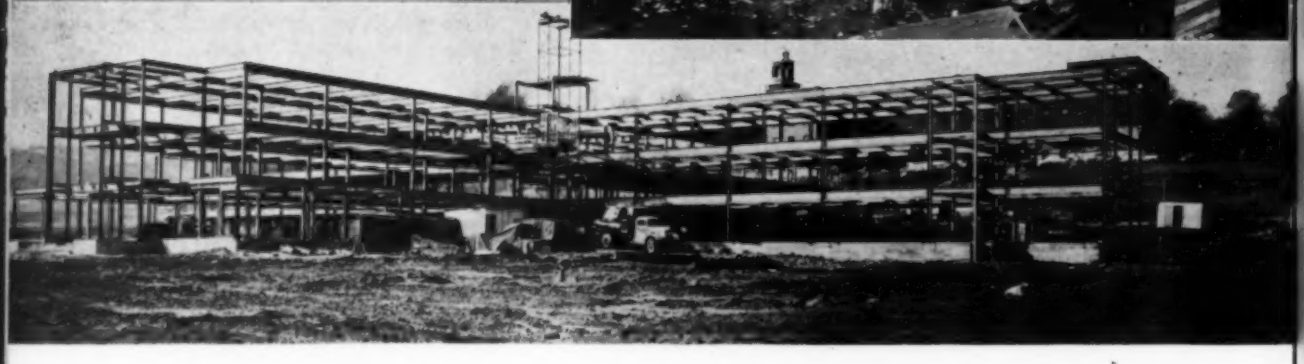

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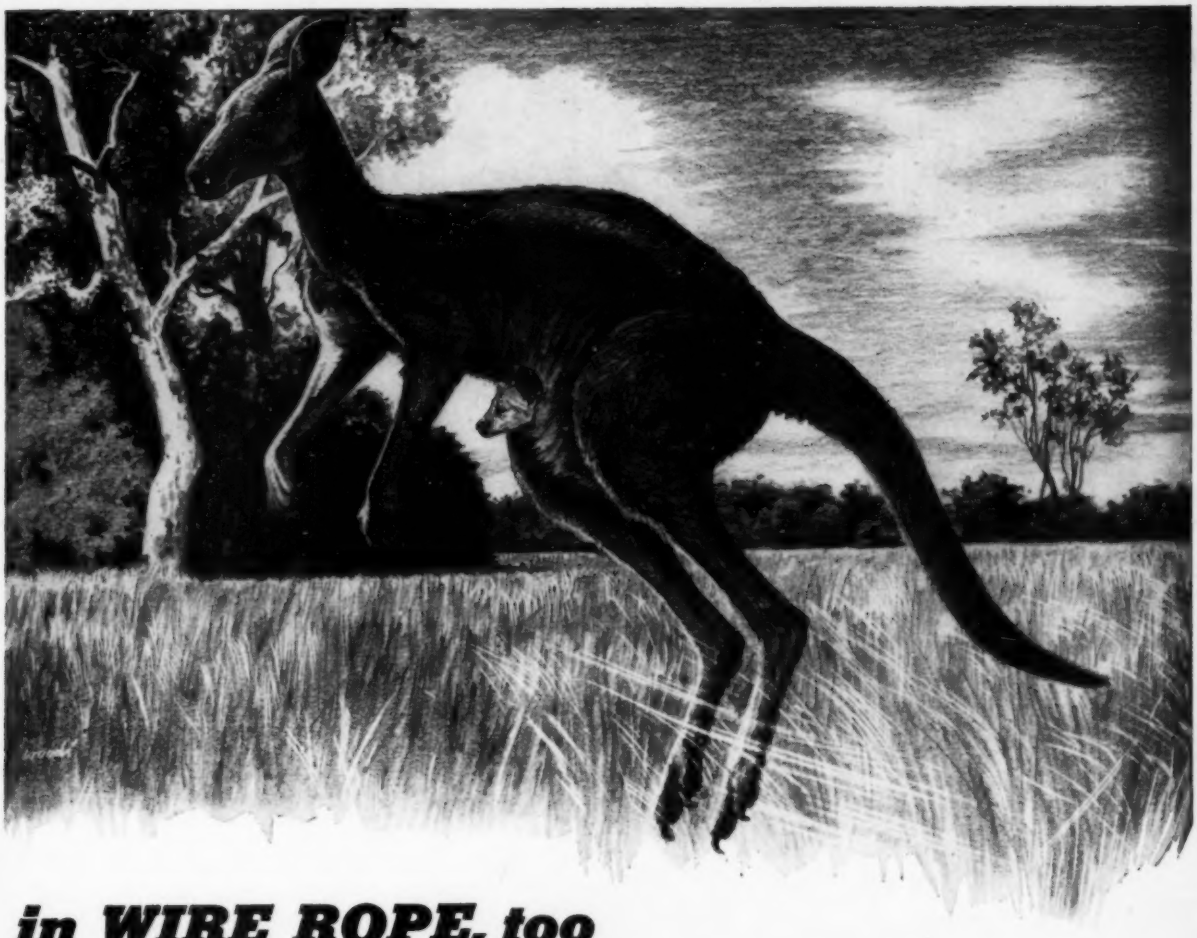

in WIRE ROPE, too the RIGHT KIND of muscle makes the difference

Endowed with highly specialized leg muscles, the kangaroo is able to make tremendous flying leaps—even with Junior perched in the rumble seat.

In wire rope, too, specialized jobs call for specialized muscles. That's why in Wickwire Rope we make sure you always get the proper combination of physical properties to best resist the destructive forces found on your particular job—whether it be abrasion, load strain, shock stress or bending fatigue.

Wickwire Rope gives you the benefit of long experience and specialized know-how which assures you of exactly the right kind of rope your particular job demands.

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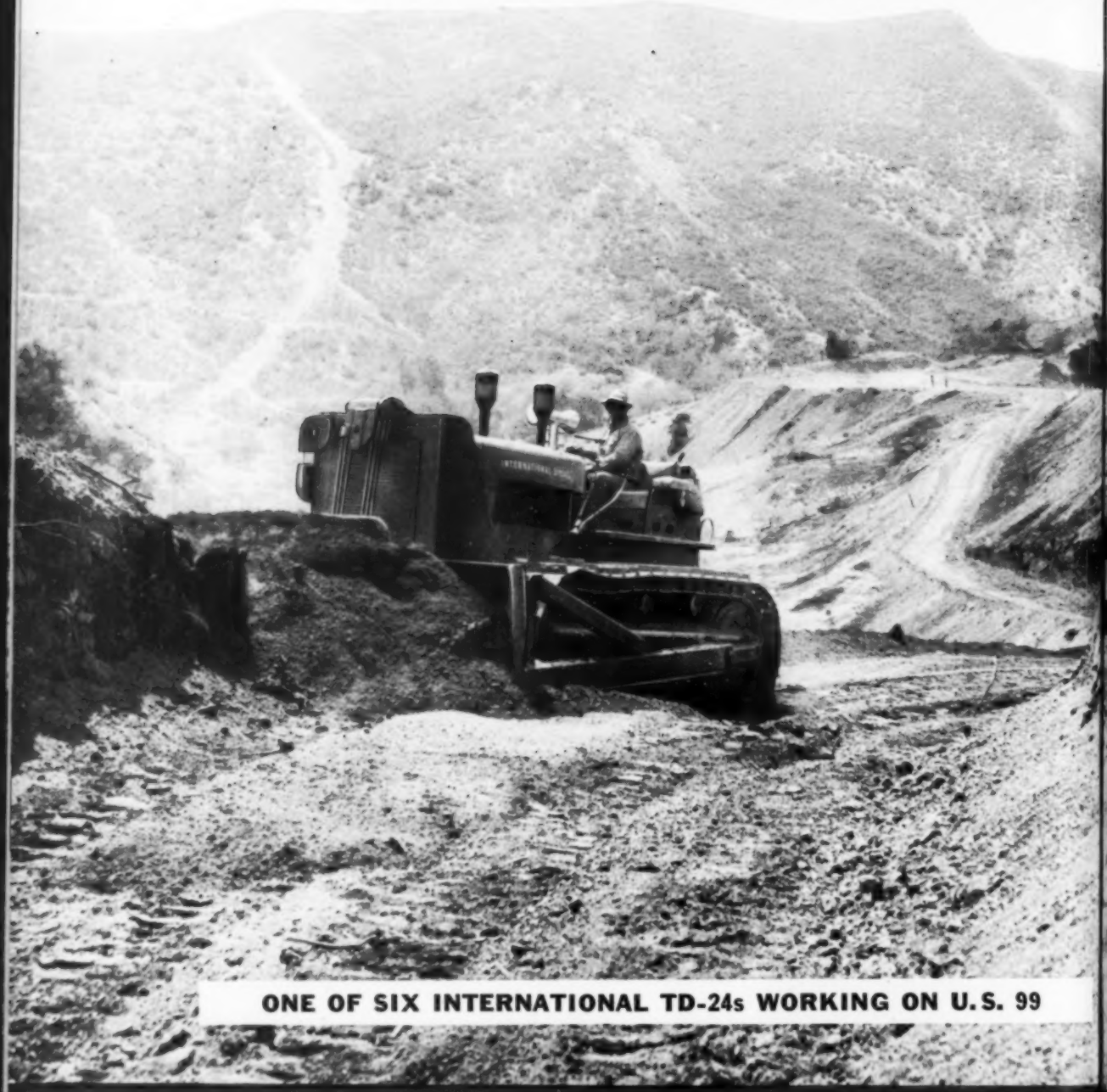
From Boulders to



ONE OF SIX INTERNATIONAL TD-24s WORKING ON U.S. 99

s to Boulevard

A. Teichert & Sons tackle huge highway job on U. S. 99 in California mountains

Fifty miles north of Los Angeles, A. Teichert & Sons are changing the face of California to modernize the main road to San Francisco.

They're digging into the rough, rocky hills with six Big Red TD-24s . . . charging in with International power to move over a million yards of boulder-filled earth—doze out cuts down to 350 feet deep—reroute a creek channel to eliminate present bridges—turn today's three-lane U. S. Highway 99 into a four-lane traffic-separated superhighway.

Teichert chooses TD-24s for the job because they're the Champs for this grueling, heavy-duty work. Here's why:

TD-24 Power—148 maximum horsepower at the drawbar, more than any other crawler on the market. Moves more dirt per hour.

TD-24 Speed—8 forward speeds, 8 reverse. Moves loads faster, gets out and gets in again faster for a faster work cycle.

TD-24 Operation—Synchromesh transmission, you shift "on-the-go." And you go up or down one speed without declutching.

TD-24 Steering—Fingertip steering for pivot turns, feathered turns, turns with power on both tracks.

TD-24 Starting—Push-button starting in any weather.

Ask your International Industrial Distributor for details on the TD-24. Consider his on-the-job service and complete shop facilities, at your call through the years ahead. Get the whole low-down! You'll be a TD-24 man from then on in!

International Harvester Company, Chicago 1, Ill.

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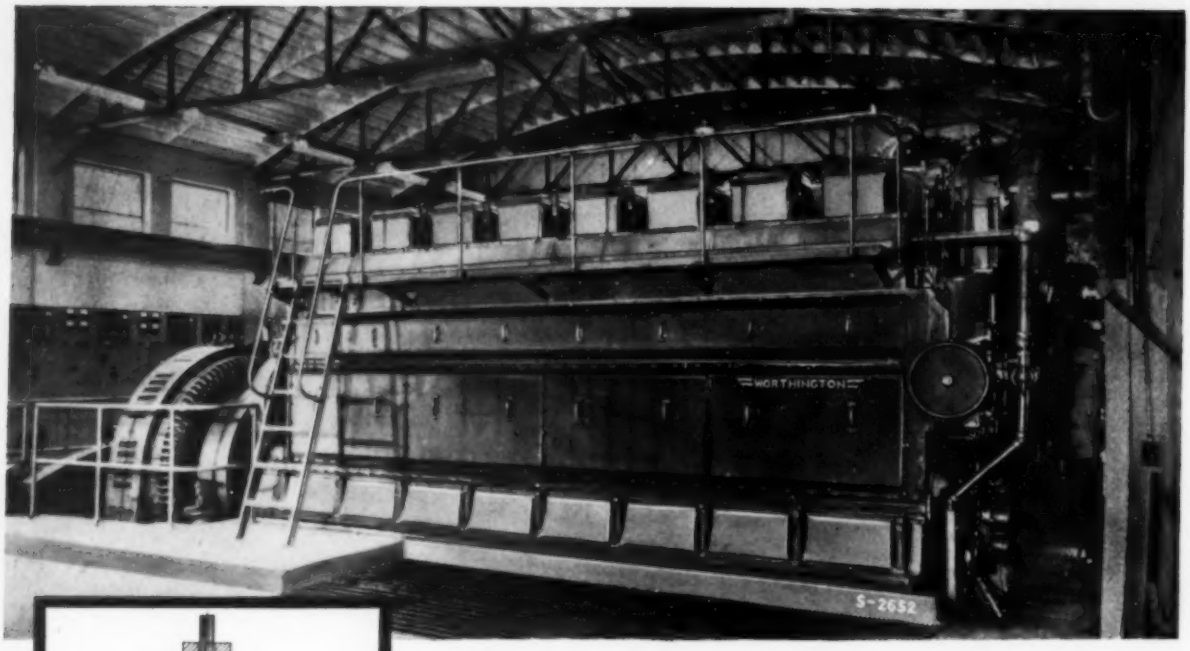
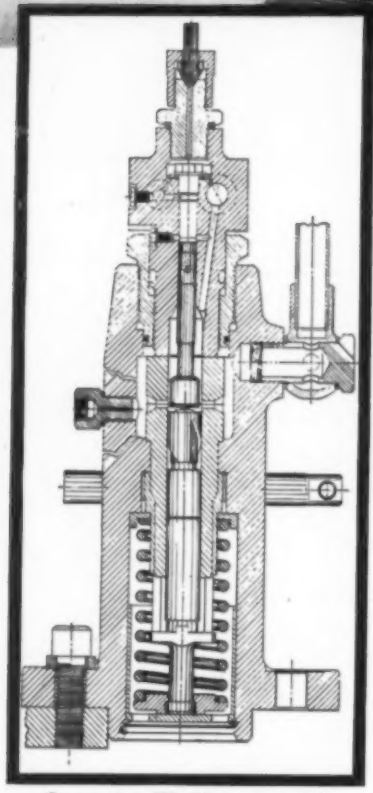
POWER THAT PAYS

1,200,000 YARDS TO MOVE—and one of A. Teichert's International TD-24s gets at it. Among crawler tractors, the Big Red TD-24 is the Champ, with more power and speed to move more paydirt per day.





Cross-section, Worthington patented dual plunger fuel pump.

This Diesel Is Ready

FOR A CHANGE IN DIET

Right now this Worthington Diesel—one of three 1760 hp units owned by the city of Tarboro, N. C.—is operating on oil.

But they anticipate natural gas in this area, and this Diesel is ready for it. With slight changes, it can easily be converted.

Worthington's patented dual plunger pumps now completely fuel this engine with oil—producing more perfect atomization, making possible the use of a *heavier* grade of oil. Also: firing pressures are reduced, exhaust temperatures, too, and combustion is improved.

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Only Worthington dual fuel engines offer such exclusives as dual plunger pumps, gas micro-metering valves for each cylinder, and automatic thermal air control—all built to give optimum performance for the fuel used.

Write for Bulletin S-500-B 31 C, Worthington Pump and Machinery Corporation, Engine Division, Buffalo, New York.

WORTHINGTON

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E.1.12

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Gas Engines, 190 to 2880 hp
Dual Fuel Engines, 345 to 2640 hp

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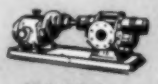
Engine Starting Compressors



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Cooling Water Circulating Pumps

Evaporative Type Engine Water Coolers

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When you specify *Concrete Joist* floor construction for your concrete building, you save materials, construction time, and cost. Furthermore, reduction of dead floor weight will permit economies in the building frame, too.

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3. SAVES TIME
—by use of ready-made forms of standard dimensions, which can be placed and removed more quickly.

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—by saving on concrete and lumber, framing, labor, and construction time.

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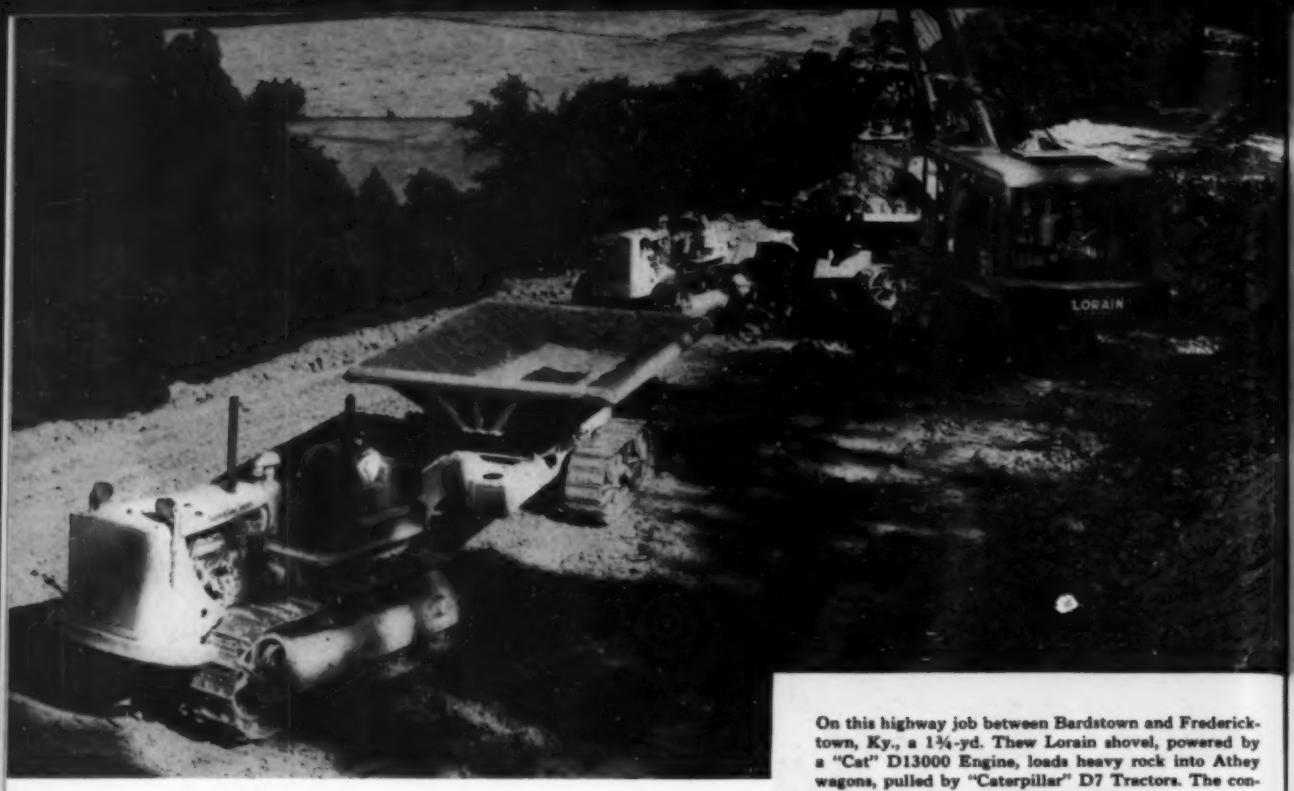

On this highway job between Bardstown and Fredericktown, Ky., a 1¾-yd. Thew Lorain shovel, powered by a "Cat" D13000 Engine, loads heavy rock into Athey wagons, pulled by "Caterpillar" D7 Tractors. The contractor is W. C. Snyder, Danville, Ky.

There's a big job ahead

How your equipment stands up in the months ahead has a real bearing on America's fight to be strong and stay free. A vital part of that effort is the $12,000,000,000 worth of earthmoving and road building needed this year. And we're entering a period that will separate "the men from the boys" in the field of construction machinery.

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"Cat" Diesel Engines, Tractors, Motor Graders and Earthmoving Equipment are built with the stamina to serve you long and faithfully. But *how* long is up to you and the operation and maintenance you give them. Good care pays off.

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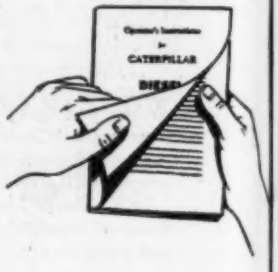
Don't let your engine overheat. Maintain the cooling system, keeping it free of scale, rust and sediment. Use soft or treated water and, when freezing temperatures exist, protect your engine with anti-freeze. Clean the radiator periodically, removing foreign matter from the core by brushing or washing. Use chemical flushing solutions. Prevent engine troubles which come with overheating. Consult your Operator's Instruction Book.



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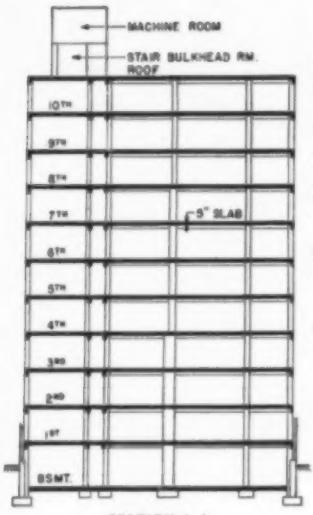


SECTION A-A

JOB DATA

Average Typical Floor

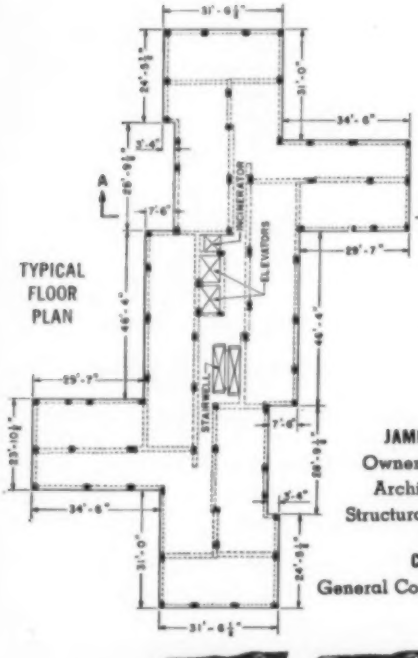
Superficial floor area
.....7,100 sq. ft.

Contact form area
.....11,000 sq. ft.
(1.55 sq. ft. per sq. ft. area)

Reinforcing steel
.....34,600 lb.
(4.9 lb. per sq. ft.)

Concrete
.....160 cu. yd.
(averaging 7.3 in. thickness per sq. ft.)

Rub and patch area
.....6,900 sq. ft.



TYPICAL FLOOR PLAN

James A. Bland Houses—Concreted with 'Incor' 24-Hour Cement —Another Example of Progress in Design and Concreting Methods

● This New York City Housing Authority project in Flushing, N.Y., again demonstrates that multi-story concrete frames, with their inherent fire-safety, are being erected at less cost than traditional types, at equal or greater speed—with these results:

1. Typical column, beam and slab arrangement, with all beams over partitions, columns generally of same dimensions from floor to roof—saves on form-work and in placing reinforcing steel;
2. No beams in rooms—reduced story height without reducing cubage;
3. Reduced height of partitions and overall exterior masonry walls—shorter vertical utility runs;
4. Columns placed off line in either direction—greater freedom for architect;
5. Forming floor slabs with plywood—eliminates need for plastered ceilings.

An Assist from 'Incor' 24-Hour Cement

Designed for concrete, the Contractor lays out the job for assembly-line speed, making fullest use of dependable 'Incor' high early strength: Minimum heat protection in cold and cool weather; stripping schedules quickly regained after rain or other delay—maximum erection speed with minimum form investment. On James A. Bland Houses, CORBETTA CONSTRUCTION CO., INC., concreted 55 floors in 100 working days, with five form-sets—one set for each 10-story building.

Plan apartments, schools, hospitals, hotels, industrial buildings with 'Incor'* concrete frames, for fire-safety and stability, lower first-cost, less maintenance. *Reg. U. S. Pat. Off.

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Architects: **CHAPMAN, EVANS & DELEHANTY**
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VOLUME 21

NUMBER 11

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NOVEMBER 1951

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The Surveyor's Notebook

Reporting on Unusual Surveying Problems and Their Solutions

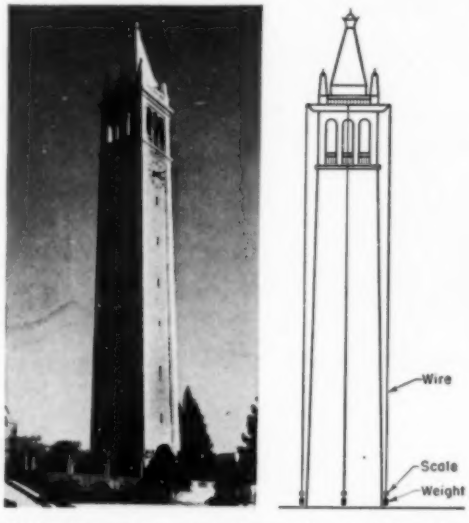
Notekeeper: W. & L. E. Gurley, America's Oldest Engineering Instrument Maker

Transits Measure Tower Movements

As part of an investigation into the cause of cracking in the granite face of Sather Tower, heart of the University of California Berkeley campus, Ned P. Clyde (Consulting Engineer) and Milos Polivka (Asst. Prof. of Civil Engineering at the University) have successfully measured the tower's movements due to temperature changes, with the aid of four transits and Nilvar wires.

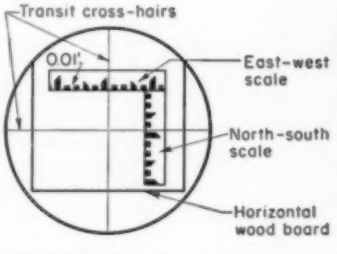
Lateral movement was determined by placing rigidly-braced, well-insulated and shaded targets at the center of each of the four faces on a balcony 228 ft. above ground and reading them with transits at base of tower. The transits were fitted with prisms which deflected the line of sight by 90 deg. and permitted observations on the scales with telescope in horizontal position. The targets were so oriented that observations could be made in both north-south and east-west directions.

Vertical movement was determined by observing markers attached to Nilvar wires suspended from the parapet wall at 224 ft. As the sun reached the tower, lateral movement (*e.g.*, 0.82 in. at 78 deg. air temp.) was in a direction away from the sun. However, vertical movement was slight (max.: 0.12 in. at 85 deg.).



Sather Tower *has steel frame fireproofed with concrete. Concrete walls have six-in. granite ashlar facing; granite masonry trim. Vertical movement was measured by markers on Nilvar wires.*

Adapted from an article in *Civil Engineering* for May, 1951, by Clyde and Polivka.



Instruments *at tower base (left): Gurley Transit, Nilvar wire and scale, and potentiometer for measuring facing's temperature.* **Lateral movement** *was determined by observing the position of cross hairs of specially-equipped Gurley Transit on two mutually-perpendicular horizontal scales of target.*

Write for Bulletin 50 giving complete details on Gurley transits, levels and other engineering instruments. And enclose a surveying tip for this page.

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Senior Structural Engineer,
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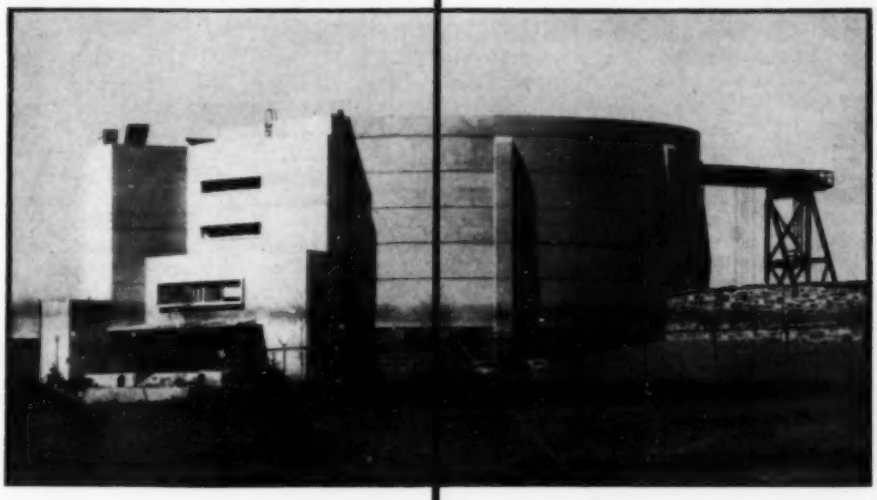


Unique laboratory houses human centrifuge

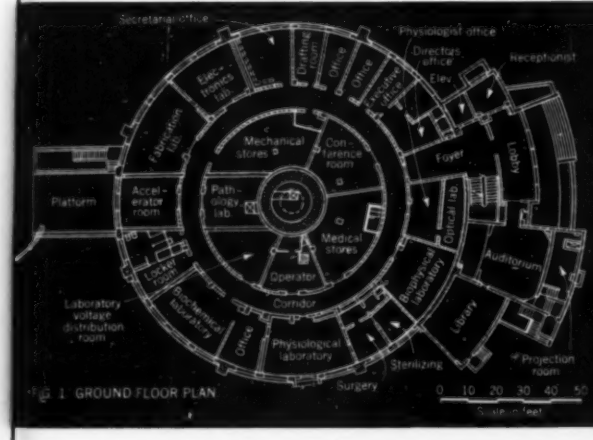


FIG. 1. GROUND FLOOR PLAN

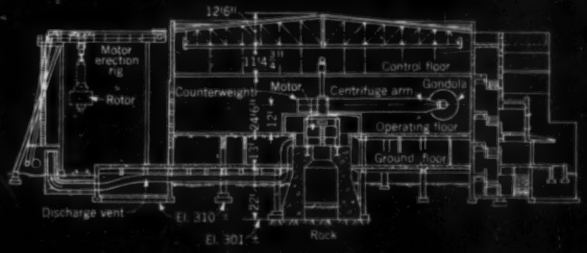


FIG. 2. CROSS SECTION

THE HUMAN Centrifuge Building at the U. S. Naval Air Development Center, Johnsville, Pa., is a laboratory for research in a special scientific field. The primary purpose of the centrifuge apparatus is to study the effects of high accelerations on human beings, and secondly to test equipment for high-speed aircraft and rocket projectiles. The performance of present and future high-speed aircraft is beyond human physiological limits and the strength of the necessary equipment. It is essential therefore that fundamental and applied research be conducted to provide methods whereby the limits of men and equipment can be increased. This human centrifuge provides new avenues of study and investigation in the fields of accelerative stress as it affects human physiology. From these studies, it is possible to develop devices for, and methods of, increasing the ability of pilots to withstand complicated flight maneuvers at high velocity.

Other existing human centrifuges are not capable of simulating actual flight, a feature which is essential for the performance of conclusive tests. These centrifuges accelerate very slowly so that the gravities, or G forces, developed by them are not directly comparable to the forces exerted on the pilot during steep turns,

dive pull-outs and spins. Time and *G* forces are interlocked in the development of derangements in physiology; that is, the longer the time the more profound the disturbance. An airplane develops *G* forces quickly in violent maneuvers, and a truer picture can be obtained by a device that develops the largest *G* forces in a minimum period of time.

These existing centrifuges have free-swinging cars and the length of their arms varies from a minimum of 12 ft to a maximum of 23 ft. A free-swinging car on a relatively short arm results in a difference in *G* stress between the different parts of the body of the subject. An airplane radius of turn is always much larger than 23 ft; hence discrepancies are certain to appear in all tests.

Advantages of New Device

The new human centrifuge device was developed to overcome these shortcomings. It has a 50-ft tubular steel arm attached to the rotor shaft of a 180-ton d-c motor, with an instantaneous rating of 16,000 hp and a normal rating of 4,000 hp. At the outer end of the arm, a gondola is mounted in a two-gimbal support (Figs. 1 and 2). As the arm accelerates, the two gimbals can be rotated by means of electric-hydraulic motors mounted on the counterweight. This permits continuous positioning of the occupant of the gondola at any predetermined angle relative to the resultant of the vertical, tangential and radial accelerations. There are also three points of suspension on the arm for auxiliary centrifuge cars at 23, 30 and 37 ft from the center.

The gondola is an oblate spheroidal decompression chamber made of aluminum-balsa sandwich material for minimum dead weight, to enable it to carry a live load of about 600 lb. This chamber has temperature control from 40 to 110 deg F, and is capable of simulating a pressure altitude of 60,000 ft. During operation of the centrifuge, the subject is studied by television and movie cameras, high-speed X-Ray equipment, and special physiological sensing and measuring devices contained in the gondola.

The centrifuge is controlled by an operator stationed in a special blister constructed under the ceiling of the centrifuge chamber. Starting, normal stopping, and emergency stopping are accomplished by push-button control.

The centrifuge arm, gondola, gimbals, counterweight and gimbal-control mechanism together weigh 84,000 lb. This mass must be revolved under close control to develop radial acceleration as follows:

From standstill to 1.5 *G* (9.4 rpm) in 0.5 sec
From 1.5 *G* to 15 *G* (29.8 rpm) in 1.35 sec
From 15 *G* to 40 *G* (48.5 rpm) in 5.0 sec

In other words, the revolving gondola must be accelerated from a dead stop to 174 mph (255 fps) in a little less than 7 sec. Meanwhile, the maximum rate of rotation of the gondola is 30 rpm.

The first decision to be made by the designers of the Human Centrifuge Building was to determine the type of structure. Since the action of the centrifuge device is rotational, it was considered that a circular structure would serve the purpose better than a rectangular one with a peripheral enclosure within the building on the operating floor. Therefore the decision was to construct a circular building of reinforced concrete.

A brief study was made to determine the practicability of using a dome as the type of roof framing. In this building, the control floor and the ceiling of the centrifuge chamber had to be hung from the roof, which might also have to carry a snow load. Since these concentrated and unbalanced loads would create high critical stresses in the dome, it was decided to support the roof on trusses.

The roof framing (Fig. 3) consists of eight radial trusses with a common member at the center. This center member is a double, extra-strong pipe with 8 gusset plates welded to each end (Fig. 4). For erection purposes the pipe was cut at midheight and later welded together in the field. The design was predicated on the following erection procedure:

First the bottom half of the center piece would be supported on an A-frame; then the radial trusses would be erected; and finally the upper half of the center member would be lowered and fitted into the top chords of the trusses.

The original site chosen for the building was underlain by silt, soft fill and sand, and a preliminary pile foundation was designed for the centrifuge motor based on the following tentative design data furnished by the designers of the centrifuge device: radial force at the arm, 344 kips; torque, 1,400 kip-ft; and overturning moment at the bottom of the grillage, 2,050 kip-ft.

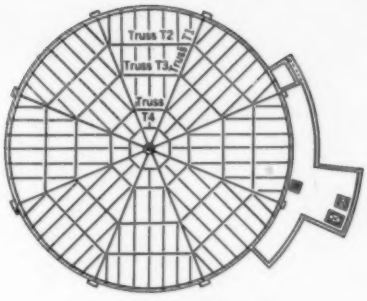
The projected pile foundation was to consist of a total of 112 piles arranged as follows: 24 piles on a 21-ft radius, battered outward radially; 24 piles on a 20-ft radius, battered tangentially counterclockwise; 24 piles on a 16-ft radius, battered tangentially clockwise; 20 piles on a 12-ft radius, 12 piles on an 8-ft radius, and 8 piles on a 4-ft radius, all to be driven vertically. An analysis of this pile group showed that the load on each exterior pile would vary from a maximum of 52 kips to a minimum of 11 kips. Such a dynamic load pulsating about 48 times per min would certainly cause uneven settlement of the piles. It was considered unwise to support an expensive and delicate device such as the human centrifuge on a yielding pile foundation. Therefore the Bureau of Yards and Docks recommended that another site be chosen—one where solid rock could be found at a suitable elevation. As a result the present site at the U. S. Naval Air Development Center, Johnsville, Pa., was chosen.

Advance Assumptions for Building Design

The building had to be completed, the laboratories equipped, and the recording instruments installed prior to the installation of the centrifuge device. Consequently the design of the building was started even before the basic requirements and operating characteristics of the human centrifuge were fully determined. The designers had to make certain assumptions in advance as to the magnitude of the loads to be carried by different parts of the structure.

While the design of the building was progressing, the designers of the centrifuge equipment decided to add a counterweight to eliminate bearing difficulties on the shaft supporting the centrifuge. To meet the required revision and complete the design of the motor foundation, the design criteria had to be revised and new assumptions made as follows: the maximum weight of motor, arm, gondola and counterweight would be 460 kips; the maximum torque transmitted from the motor to the motor foundation would not exceed 2,000 kip-ft; the maximum unbalanced radial force at the centrifuge arm would not exceed 100 kips. The final figures determined by the designers of the centrifuge indicated that none of the assumed quantities was exceeded.

Since the forces acting on the motor foundation are dynamic and practically instantaneous, and since considerable vibration may be induced in the foundation, it was decided to adopt a very conservative design. The dimensions of the foundation were assumed, and the actual stresses computed. The bearing pressure at the toe is 5.45 kips per sq ft, and at the heel 2.39 kips per sq ft. The shearing stress in concrete at the smallest cross-section is 8.0 psi and at



ROOF TRUSSES RADIATE from common center-post. Use of dome-type construction was ruled out since controls, which were hung from roof, would create concentrated, unbalanced loads. For erection purposes, center post was cut in middle. Lower section was supported on A-frame while eight radial trusses were erected. Upper half was placed last, being fitted to erected trusses.

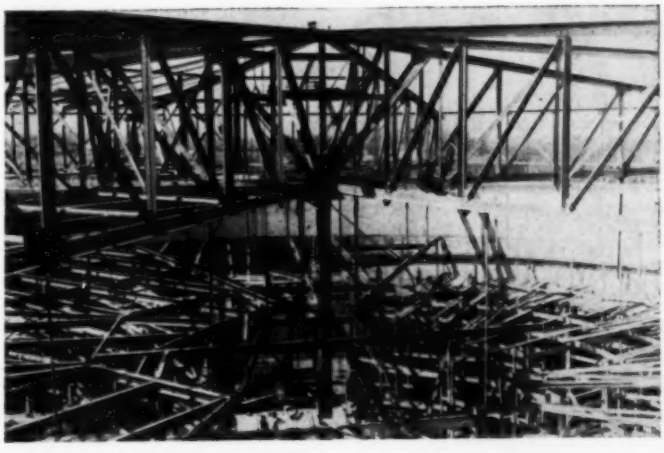
FIG. 3. ROOF FRAMING PLAN
0 10 20 30 40 50
Scale in feet

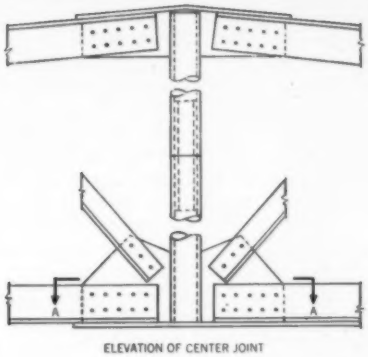
the bottom, 3.3 psi.. The resisting frictional force at the base is 17.7 psi, based on the assumed value of 0.65 for the coefficient of friction for concrete on rock. The total weight of the foundation, motor and centrifuge equipment is approximately 1,300 tons.

The designers of the centrifuge motor specified thirty $2^1/_2$-in.-dia bolts, on a radius of 6 ft $9^7/_8$ in., to transfer the torque to the foundation. But it was considered unsafe to transfer a 2,000-kip-ft torque from the motor directly into concrete by bolts. Therefore it was decided to transfer this torque from the motor to a base ring (Fig. 5) and from the base ring into the foundation by shear keys.

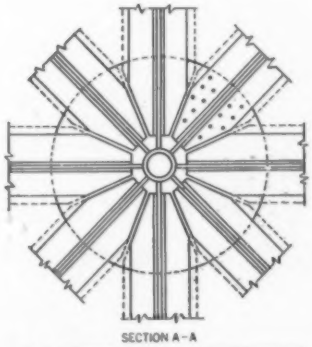
The main purpose in arranging the reinforcing for the motor foundation (Fig. 6) was to keep it a solid mass by preventing any cracks which might be caused by the great differences in temperature developed between the interior of the mass and the exterior surfaces during hydration of the cement. The area of reinforcing is approximately 0.1 percent of the area of concrete.

The exact method of handling the motor had to be determined in advance for the design of the platform and the motor tunnel framing, taking into consideration not only the original installation but also the possible removal and replacement of the motor. The proposed plan was to assemble the motor on a low dolly on the platform, and then to jack up both the motor and the low dolly bodily and mount them on a high dolly, on which they would be rolled toward the motor foundation. Then the motor on the low dolly would be rolled over the motor foundation on temporary rails. After the motor was jacked up, the low dolly and the rails would be removed and the motor lowered and placed in its final position. The total weight of the motor, fully assembled, and of the two dollies was assumed to be 400 kips.





ELEVATION OF CENTER JOINT



SECTION A-A

FIG. 4. CENTER JOINT OF MAIN ROOF TRUSSES
0 1 2 3 4
Scale in feet

BASE RING transfers 2,000 kip-ft torque from motor into foundation by means of shear keys. Load was considered too great to be transferred directly from motor to concrete by bolts.

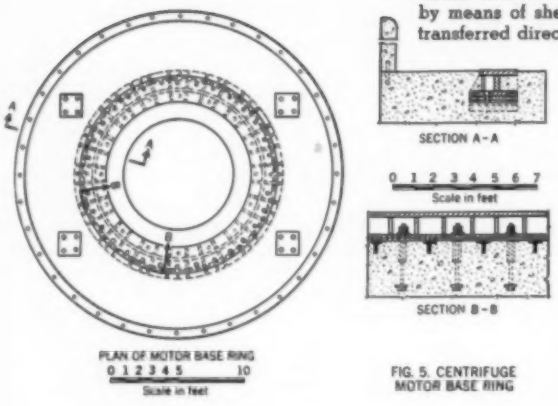


FIG. 5. CENTRIFUGE MOTOR BASE RING

CONSERVATIVE DESIGN of motor foundation (below) was necessitated by tremendous dynamic forces developed by centrifuge. It was necessary that concrete remain a solid mass without any cracking caused by great differences in temperature between interior and exterior during hydration of cement. Area of steel is 0.1 percent of area of concrete.

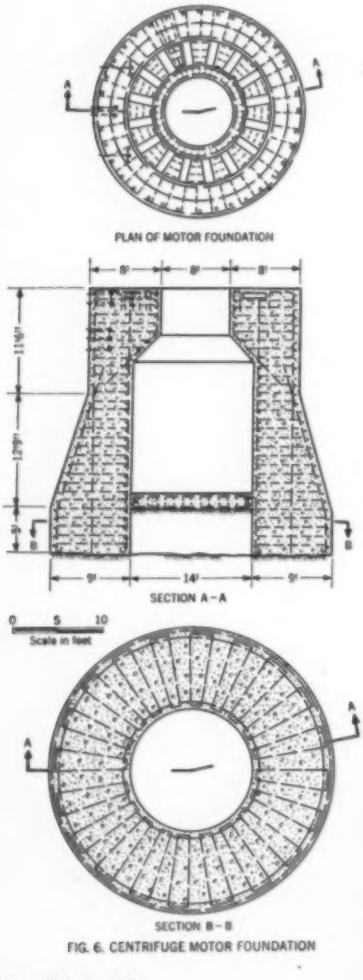


FIG. 6. CENTRIFUGE MOTOR FOUNDATION

Design of a reinforced concrete framing for the motor tunnel indicated excessive vertical and torsional shear in the main girders amounting to a combined shear of 405 psi for a 24 × 42-in. girder. This was considered unsafe for such a heavy loading. Therefore the framing of the motor tunnel was changed to structural steel, similar to that for a deck girder bridge, and was encased in concrete. The roof of the motor tunnel, serving also as part of the operating-floor framing, was made removable in anticipation of the possible necessity of replacing the motor in the future.

All areas in the building containing delicate instrumentation are shielded from conductive and radiated electrical interference, including the centrifuge motor. The shielded areas are the centrifuge chamber, control room on the control floor, physiologist's preparation room on the mezzanine floor, and the electronics, physiological, surgical, medical and biochemical laboratories on the ground floor.

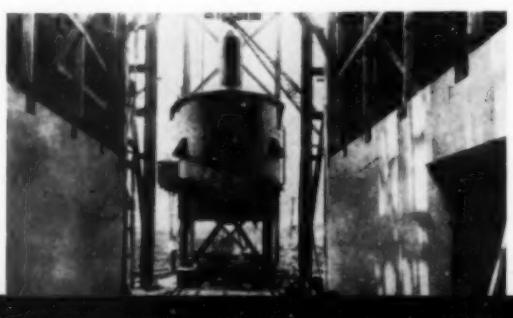
In the centrifuge chamber the walls are covered completely with sheet copper, weighing 40 oz per sq ft. The floor is similarly shielded except that there is a 3-in. wearing coat of concrete on top of the copper. The ceiling is covered with perforated copper of the same weight and thickness. Similar construction is used in the laboratories on the ground floor.

Underneath the entire building a layer of copper mesh was installed and extended through the foundations to the outside of the building. A series of bare copper wires, extending radially from the building at intervals of 2-deg arcs, are connected to the perimeter of this ground mat. All this grounding material is connected to the shielding in the various rooms as noted above, so that the entire structure is grounded electrically.

The Human Centrifuge Building has more recently been renamed "The Aviation Medical Acceleration Laboratory." By agreement between the Department of the Navy and the University of Pennsylvania, the laboratory is considered as an integral part of the university. The basic research problems within the mission of the laboratory are technically sponsored by both the Navy and the University of Pennsylvania.

The Human Centrifuge Device was designed by the Special Devices Center of the Office of Naval Research and McKiernan-Terry Corp., Harrison, N. J. The centrifuge motor was designed and built by General Electric. The building was designed by the Bureau of Yards and Docks, under the direction of Rear Admirals John J. Manning and Joseph F. Jelley, CEC, USN, respectively former and present chiefs of the bureau. The building was constructed by Ralph S. Herzog, Inc., of Philadelphia, contractor.

(This article is based on the paper presented by Mr. Bagdoyan at ASCE's New York Annual Convention, before the Structural Division session, presided over by Jewell M. Garrelts.)



MOTOR was assembled on platform outside of building on movable dolly. Then both motor and low dolly were jacked up onto high dolly and rolled to motor foundation.

Centennial marks a century of engineered progress

LENOX R. LOHR, M. ASCE
President, Centennial of Engineering, 1952, Inc., Chicago, Ill.

WHY, with less than 7 percent of the world's population, have we in the United States over a third of the world's goods? Because we have had a century of engineered progress. By the year 1852 the need of an organization by which engineers might share their ideas and the results of their work was realized, so the American Society of Civil Engineers was formed. The year 1952 marks the centennial of that first association of engineers in this country and merits a nationwide celebration. But it would be a lost opportunity if confined to engineers patting each other on the back and merely reviewing their own accomplishments to themselves.

Plans for the Centennial envisage three major parts:

1. The greatest convocation of engineers ever assembled, with over forty technical societies with a combined membership of over 300,000, meeting jointly in Chicago, September 3–15, 1952. The many hundreds of papers delivered will cover almost every phase of engineering. The discussions will be broad in scope so that members of other societies interested in activities collateral to, or outside their usual sphere can fully understand them. It will present an unusual opportunity for engineers to receive accurate information in fields not usually accessible.

A volume will be printed listing all papers to be presented so that visitors can select and attend meetings in any field in which they are interested.

2. There will be a dynamic exhibit at the Museum of Science and Industry epitomizing all engineering progress and its effects on our way of life. It will remain for five years and over eight million people will see it.

3. There will be a dramatic presentation, using all the arts of the stage, to tell the story to the general public. It will run through the summer months of 1952. It will be the story of civilization's march forward and particularly of the Century of Engineered Progress, told factually and with real equipment, but basing its appeal on entertainment and stimulating the emotions.

The main purposes of the Centennial may be summed up as to:

1. Make known the contributions of the engineer in peace and war to our national progress.
2. Personalize the engineer in his true role.
3. Stimulate young men to study engineering to fill the future's great need of technically trained men in research and industry.
4. Depict the role of industry, with its mass production, as essential to our high standard of living, and its dependence on the engineer and on management to maintain and increase our prosperity.

The work of the scientist, the industrial researcher, the inventor, and the engineer are so correlated that there is only a twilight zone of distinction among them. They merit the highest praise from their fellow Americans, but that is unimportant. What is vital, if our way of life is to survive, is that the people fully understand and appreciate the role that these men play in our modern industrial world. Many Americans do not appreciate the factors that have made us the most powerful nation in the world. We have not found effective means of getting the facts to them. The Centennial of Engineering presents this opportunity.

For instance, some people think that mass production connotes shoddy goods, carelessly and hurriedly made to sell cheaply. The Centennial must show that mass production means precisely designed machines, capable of the highest accuracy to assure interchangeability of parts, which is the essence of mass production and the assembly line.

The facts must be presented to the people so that they will reach their consciousness through their hearts rather than through their minds. The effectiveness of appeals to emotion and to reason is in the order of 100 to 1, a ratio that can be substantiated. Mail response is the best method of determining the acceptance of a radio broadcast, so all letters and phone calls are carefully tabulated by the networks.

A speech by Herbert Hoover on the state of the Nation brought 2,998 replies. Two talks on the work of the United Nations produced 1,030 and 45, respectively. The largest number of responses ever received to a serious program, a religious one, was 10,045.

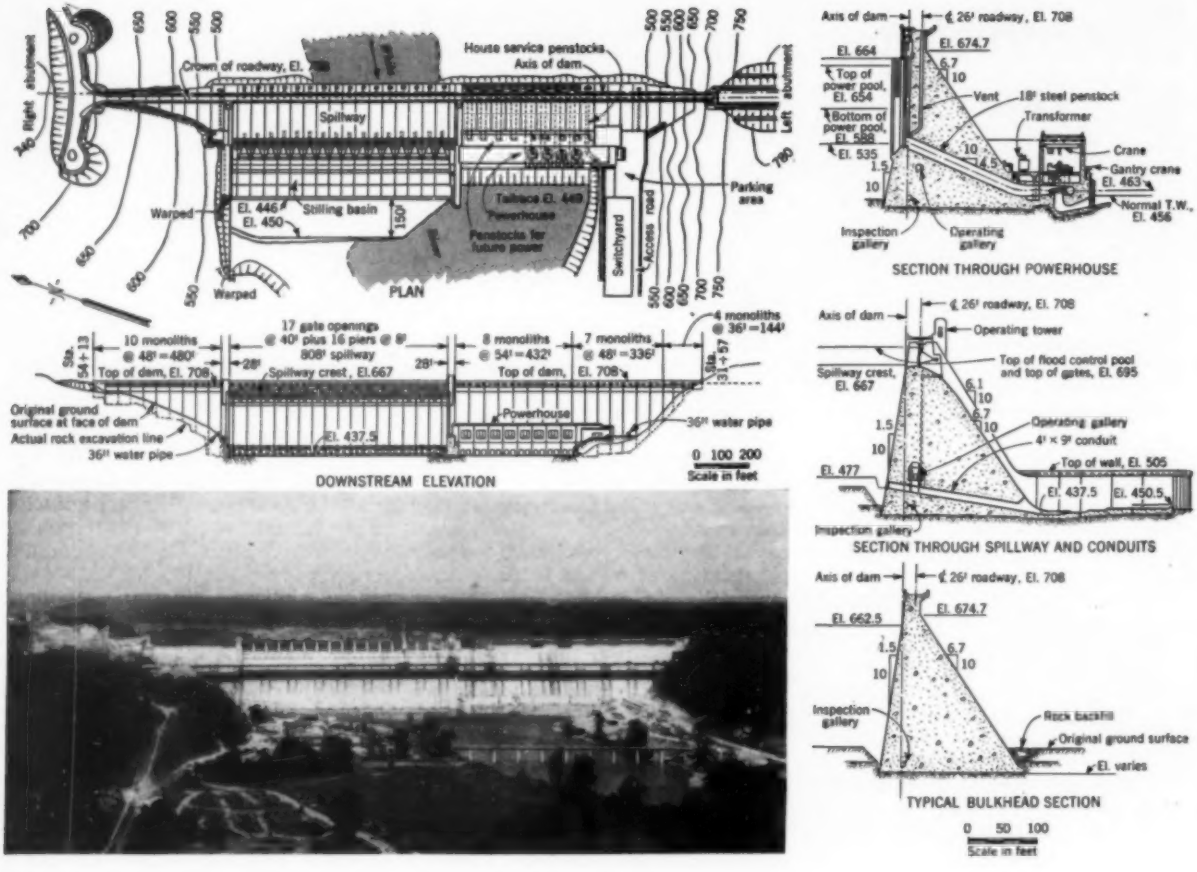
Now let's see what an emotional appeal brings forth. On one occasion the audience was asked to send a greeting to a crippled child on her eighth birthday. She received the largest mail ever delivered to a single address in St. Louis. A ten-year-old infantile paralysis victim sang *Over the Rainbow* in a cracked voice and asked for support of the March of Dimes, and 1,395,000 replies were made to this single request.

Emotional appeals on the commercial side produced these surprising results: A "Name the Baby" contest produced 2,253,000 entries. A million copies of Sinclair's dinosaur album were exhausted in 48 hours. An offer of some of "Ma Perkins'" *own* petunia seeds brought in 1,100,000 dimes.

I have put special emphasis on an approach through the emotions because it has been generally overlooked. But such an appeal does not infer a distortion of facts or juggling of truth. It means a down-to-earth presentation of facts so that the mass of the people will readily absorb them.

American industry, functioning under the aegis of a Constitution which guarantees liberty, is the bulwark of world stability. We have the media of mass communication so that all the people are aware of what is available, mass transportation to ship goods to the remotest corner of the country, and a sharing of the profits to all who would invest. This is the story the Centennial must tell.

(This article is an abstract of Major Lohr's address before the Membership Luncheon at the ASCE Annual Convention in New York.)



Bull Shoals Dam now completed

WORK on Bull Shoals Dam was completed in October 1951 and the first generating unit of the power plant is scheduled to go into operation in June 1952. The dam is on the White River about 10 miles south of the Missouri-Arkansas state line, about 115 miles north of Little Rock, Ark., and 225 miles southwest of St. Louis, Mo.

It is a concrete gravity-type structure containing about 2,100,000 cu yd of concrete. The power plant adjoins the dam and will contain initially four 40,000-kw units with provision for four additional units.

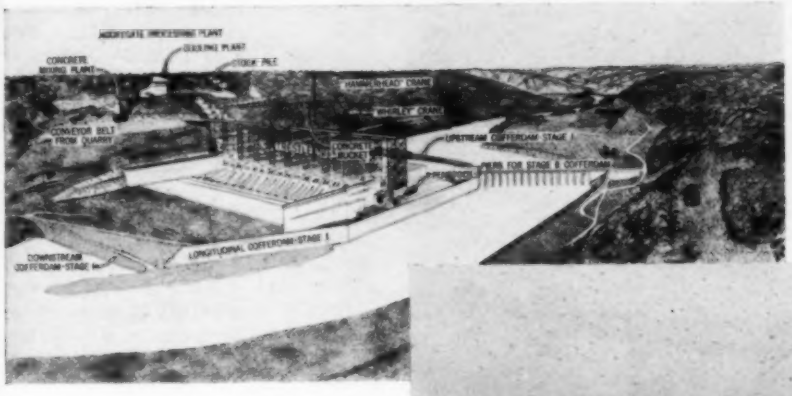
The project is being constructed for the combined purpose of flood control and the generation of hydroelectric power. The drainage area upstream from the dam is 6,036 sq. miles and represents nearly one fourth of the total area of the White River Basin. Consequently the dam will effect large reductions in flood heights.

The White River in the vicinity of Bull Shoals has long been recognized as having potentialities for the development of hydroelectric power. Investigations by private power companies were made as early as 1910 but their studies were based on a dam at Wild Cat Shoals about 10 miles downstream from the Bull Shoals site. The latter site was developed as a result of an investigation authorized by Congress and reported in 1940. The report recommended that Bull Shoals and Table Rock, which is upstream from Bull Shoals, be constructed for the control of floods; for the development, transmission, and sale of hydroelectric power; and for other beneficial uses.

The average annual rainfall is about 45 in., and the flow of the river at the dam site has varied from a minimum of about 105 cfs to a maximum of about 240,000 cfs. The average annual flow is 6,430 cfs, equivalent to about 14.5 in. on the drainage area above the dam. The storage provided for flood regulation would have reduced the floods of record up to this time to a maximum of about 70,000 cfs, and the storage provided for flow regulation for power would have increased the minimum flow to about 4,000 cfs.

Comparative studies were made of various types of dams. Insufficient materials were available for a rolled earth-fill dam, and cost studies indicated that the advantages of a concrete dam over rock fill would more than compensate for the slight difference in first cost. Likewise it was concluded that there would be little if any saving in cost by using a thin-section concrete dam such as slab and buttress, round-head buttress, or multiple arch.

The dam site is located on a rock outcrop in a swift, shallow reach of the White River known as Bull



STAGE 1 DIVERSION provided for 300-ft channel along south bank of dam site with capacity to divert 150,000 cfs. Stage 1 construction involved placement of concrete in Monoliths 17 to 36 inclusive to El. 491, and in Monoliths 18, 19, 20, 37, 38, and 39 to higher elevations to provide required diversion for Stage 2.

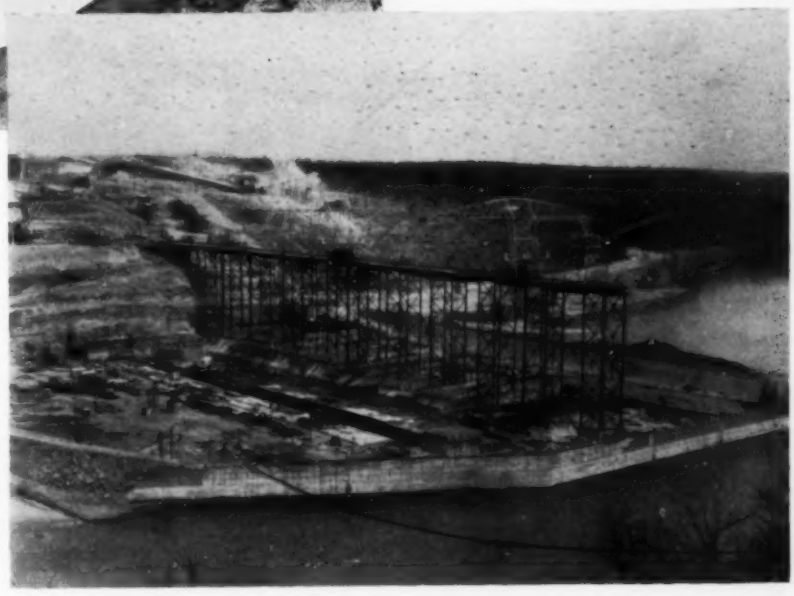


FIG. 1. PLAN, elevation and sections of Bull Shoals Dam show character of concrete gravity structure containing slightly more than two million cubic yards of concrete. This type of structure proved to be more economical than buttress or multiple-arch type. Site material was not suitable for rolled-earth fill.

H. V. PITTMAN, M. ASCE, Engineer, Little Rock District, Corps of Engineers, Little Rock, Ark.

Shoals, from which the project derives its name. There is a steep bluff formation at the south abutment and a moderately steep uniform slope at the north abutment. The abutments rise 310 to 330 ft above the river channel. The flood plain has an average elevation of 478 ft above mean sea level. The river channel is 480 ft wide and the stream bed is on bedrock at an average elevation of 450 ft.

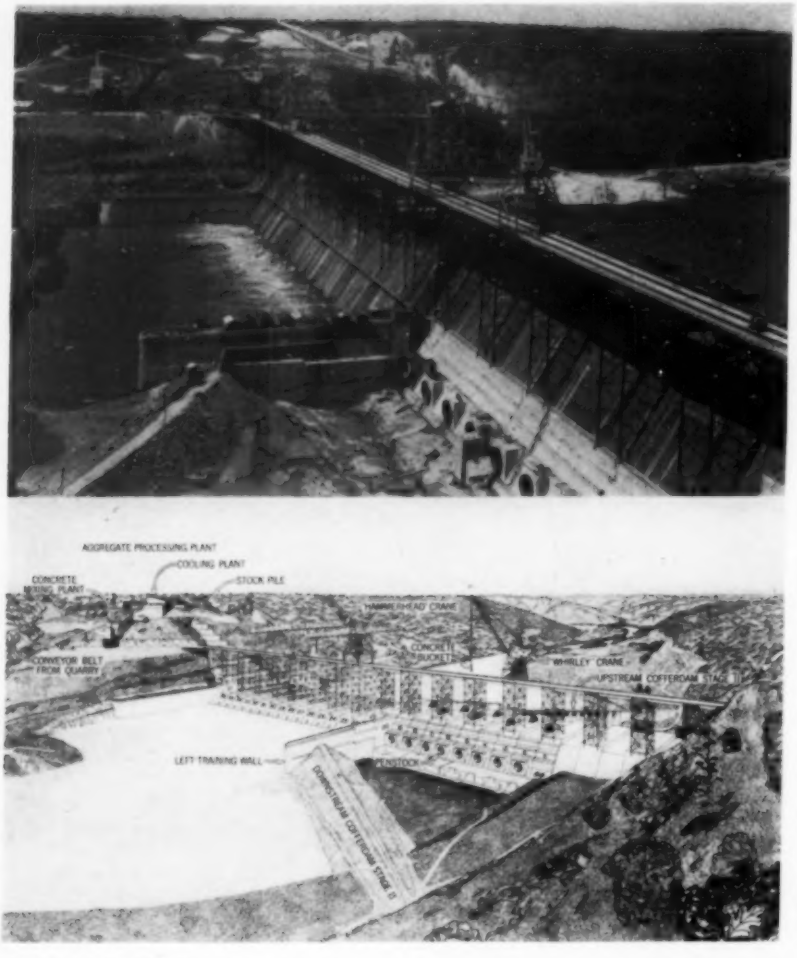
Careful Exploratory Drilling

The rock forming the abutments is known to geologists as the Cotter formation. It consists of alternating beds of blue-gray, crystalline, thin-bedded, dolomitic limestone with paper-thin shale laminae and mottled gray medium-bedded, cherty, fractured limestones. Beds of sandy limestone and blue-gray chert occur throughout the formation. The beds vary in thickness from 0.2 to 8 ft and they have an average thickness of 2 ft.

The base of the dam between the abutments is in the Jefferson City formation, which is also a dolomitic limestone, some parts of which are massive and others are thin-bedded. It is gray, very hard, crystalline, vuggy, and somewhat cherty, with numerous fractures which are recemented.

Foundation explorations for final selection of the site included 183 holes of 3-in. diameter, totaling nearly 13,000 lin ft of rock drilling with a core recovery of 95 percent. About 435 lin ft of Calyx holes, 36 and 40 in. in diameter, were drilled to examine and determine the extent of some cavernous areas that were disclosed by the 3-in. holes. From these explorations, the axis of the dam was selected and an approximate, firm rock grade determined on which to found the dam. Additional explorations were made by the contractor as excavation progressed to accurately locate the bedding planes and the maximum elevation at which a suitable foundation could be obtained. In general, the rock was found to be sound and free from intensive fracturing, solution channels, cavities, or serious weathering.

The dam is a straight concrete gravity-type structure with an overflow spillway 808 ft long near the north abutment and an eight-unit powerhouse adjoining the spillway section on the south (Fig. 1). The spillway crest is at El. 667. Seventeen radial-type steel gates 40 ft long and 28 ft high permit the storage of water to El. 695. The piers supporting the spillway bridge and the radial-gate trunnions are located on the center line of the spillway monoliths. A conduit 4 ft wide by 9 ft high, controlled by hydraulically operated slide gates, is also on the center line of each monolith.



STAGE 2 DIVERSION provided for flow of 150,000 cfs over low lifts and conduits poured in Stage 1. Downstream cofferdam was left for removal by powerhouse contractor. Powerhouse was constructed during Stage 2.

The stilling basin, extending 203 ft downstream from the toe of the spillway, is anchored to the rock and is stepped for economy of construction and effective dissipation of energy. The velocity of the water entering the stilling basin will be about 125 fps and the estimated average velocity over the end sill will be about 10 fps. The design of the basin was checked and improved by model studies made at the U. S. Waterways Experiment Station, Vicksburg, Miss.

The dam contains two main galleries. The lower one, 5 ft wide by 7 ft high, is for inspection, drainage, and grouting. This gallery extends the entire length of the dam following the profile of the foundation. Provision was made for drilling and grouting a cutoff curtain beneath the dam and drilling drainage holes immediately downstream therefrom, all work to be performed by Government personnel.

The other gallery is for access to the gate-operating chambers and extends through the spillway section and the penstock monoliths. It is provided with recesses to accommodate the gate-operating cylinders and, in the penstock section, to accommodate the piping and valves for filling the penstock.

An operating tower at the left end of the spillway will contain an elevator, office space, and a gasoline-electric standby unit for emergency service.

The eight penstocks, having a diameter of 18 ft and spaced 54 ft center to center, were installed through the non-overflow section immediately to the left of the spillway. The penstocks are lined with steel plate and the four connected to the turbines, to be installed initially, have tractor-type gates about 19 ft wide and 26 ft high. The other four penstocks have been sealed on the upstream end by steel bulkheads.

The turbines will be the Francis type with a capacity of 62,000 hp each with a net effective head of 190 ft, and 65,500 hp with a net effective head of 197 ft (full power pool). The turbine runners will have a discharge diameter of 152 $^1/_2$ in. and will turn at a rate of 128.6 rpm.

Each generator will have a normal rating of 40,000 kw at a 0.95 power factor and will permit the operation of the turbines at peak efficiency below a net effective head of 197 ft. Power will be generated at 13,800 v and will be stepped up to 154,000 v for transmission purposes by transformers on the transformer deck between the powerhouse and the dam.

The switchyard is located downstream from the powerhouse on the south bank of the river. Two house-service generating units will provide power for use in the dam and powerhouse. They are rated at 1,500 hp and will have a normal capacity of 1,000 kw at an 0.8 power factor. The main turbines and generators are being furnished by Allis-Chalmers Co., the house-unit turbines by the James Leffel Co., and the house-unit generators by General Electric Co.

Design of the power plant was executed under a contract with the Harza Engineering Co., Chicago, Ill., Erik T. Floor and Associates, Chicago, Ill., and by the Hydroelectric Design Branch, Southwestern Division, Corps of Engineers, Dallas, Tex.

The 26-ft-wide roadway on top of the dam will provide a new crossing of the White River between Cotter, Ark., and Forsyth, Mo. On each side of the roadway there is a 4-ft-wide sidewalk. The oval pipe handrailings on the outside are supported by concrete parapets. The roadway is lighted by fixtures recessed in the parapet walls.

Design of the non-overflow section of the dam is based on a triangular section having a base-to-height ratio of 0.82. The upstream face has a slope of 10 on 1.5, and the downstream face a slope of 10 on 6.7, with the intersection of the slopes occurring at the design pool elevation (El. 703). Stability analyses were based on conventional assumptions with uplift pressures effective over two-thirds of the base so that the resultant pressure would be well inside the middle third of the base. and the ratio of horizontal to vertical forces would be about 0.6. Analyses

using earthquake force with an acceleration factor of 0.1 gravity indicated that the resultant was somewhat outside the middle third of the base, and the ratio of horizontal to vertical forces about 0.8.

The spillway design storm for Bull Shoals was assumed to be 15.2 in. of rain in 72 hours, and the runoff was computed on the basis of a uniform infiltration rate of 0.04 in. per hour. The peak outflow of the spillway was determined to be 545,000 cfs.

Plans are being made to develop recreational facilities in the reservoir area in cooperation with state and federal agencies and in conformity with the policy of making the lake and the Government-owned land surrounding it available to the public to the fullest extent compatible with orderly and planned development. Construction of recreational developments on privately owned lands adjacent to the project area is encouraged, and project lands that are suitable for agricultural or grazing purposes, and not required for other purposes, will be leased in accordance with a sound land-use program developed in cooperation with the U. S. Soil Conservation Service.

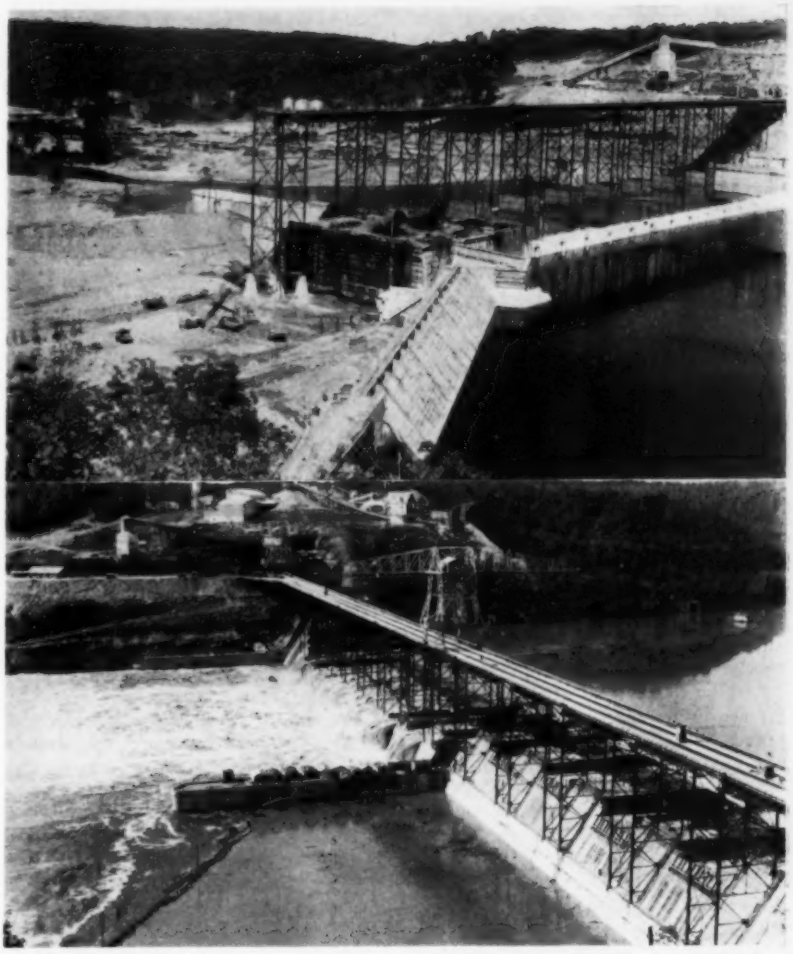
Three Separate Construction Contracts Let

Construction of the main dam and powerhouse and the furnishing of concrete aggregates involved three separate contracts. The contract for the dam was awarded May 8, 1947, to the Ozark Dam Constructors, a combination of nine construction firms including Brown and Root, Inc., of Houston, Tex., sponsor of the joint venture, on a low bid of $22,146,440. The contractor started work June 24, 1947, and the work was scheduled for completion within 1,250 calendar days.

The contract for furnishing aggregates for the main dam was awarded November 3, 1947, to the same contracting combination composing the Ozark Dam Constructors but organized and doing business as the Flippin Materials Co. of Houston, Tex., with Brown and Root, Inc., as sponsor on a low bid of $9,301,000.

The contract for the powerhouse and switchyard was awarded June 1, 1950, to the Ozark Dam Constructors on a low bid of $4,493,001. Work started August 7, 1950, and was scheduled for completion by August 1952.

Cement required for permanent concrete was furnished by the Government. Concrete aggregates for the powerhouse contract were furnished by the Flippin Materials Co., on the same unit-price basis as for the main dam under contract modification. Separate contracts were awarded for furnishing Tainter gates, turbines, generators, and other equipment.



BUTTRESS-TYPE diversion structure (top view) was constructed in the dry during building of cofferdams for Stage 1. Piers were not built to final grade but temporarily bridged for access until just prior to Stage 2 diversion. Closure for Stage 2 diversion was effected by dropping concrete stop-logs into diversion structure. During second stage, 180,000-cfs flood hit construction site and overtopped downstream cofferdam (lower view), causing considerable damage and loss of ten days of construction time.

Work performed in advance of actual dam construction consisted of construction of access roads on the north and south banks totaling 18 miles; an access railroad 16.5 miles long; an office and service building for supervisory Government employees; and additional housing units in the Government-owned village in nearby Mountain Home for the accommodation of married Government employees.

The contractor's approved plan for the construction of the dam provided for two-stage diversion. Stage 1 provided for the excavation of a diversion channel along the left bank having a width of 300 ft, a bottom elevation of about 452, and a discharge capacity of 150,000 cfs (see sketch, p. 27). This channel was provided with a buttress-type, reinforced concrete diversion structure with top elevation at 509.5, located upstream from the dam, equipped with reinforced concrete stop-logs for use during Stage 2 diversion. The foundation slab and piers to partial final elevation were built in the dry during the construction of Stage 1, and the piers were temporarily bridged for access to cofferdam area No. 1. Piers were raised to final grade just prior to Stage 2 diversion.

When Stage 2 diversion was

started, these stop-logs were first placed and then a downstream earth cofferdam, with crest elevation at 485.5 was built between the left training wall and the left bank, and bulkheads placed in the penstocks of Monoliths 18 and 19, thus providing for a discharge of 150,000 cfs through the conduits and over the low monoliths. Stage 2 diversion also provided for the construction of the powerhouse, with responsibility for the removal of the remaining cofferdam transferred to the contractor for the powerhouse. The dam and powerhouse were thus constructed by means of two-stage diversion.

In May 1950 a major flood occurred. The crest was at El. 524, and the discharge over the low diversion monoliths was about 180,000 cfs. This flood overtopped and partly destroyed the downstream cofferdam and did considerable damage to the permanent work, thus delaying normal operations about 10 days.

A total of 463,000 cu yd of common, and 590,000 cu yd of rock excavation was required for the main dam and powerhouse. This work was performed by jackhammers, wagon drills, power shovels, draglines, dump trucks and similar equipment. Suitable excavated materials were utilized as backfill in the cofferdams and as slope paving, and the remainder was wasted in spoil areas.

With few exceptions the rock foundation for the dam and powerhouse was found to be sound and tight. The final established foundation grade corresponded closely to the assumed firm rock line established from the previous field investigations used as the basis for design of the structures. However, the two large clay and rock-filled cavernous areas, one near the toe of the north abutment slope and the other in the flood plain in the vicinity of the downstream left training wall, were further drilled and explored. These areas were then excavated to firm rock and refilled with mass concrete. A few solution channels common to limestone formations were also encountered. These were economically and satisfactorily treated. Core recovery was good and grout consumption low. Drilling and grouting work involved the following quantities:

	Grouting Cu ft	Drilling Lin ft
Foundation exploration, holes of 3-in. diameter	7,920	24,363
Foundation exploration, holes of 36- to 40-in. diameter	....	194
Cutoff curtain, holes of 1 1/2-in. and 3-in. diameter	25,000	42,000
Drainage holes, of 3-in. diameter, for relief of uplift pressures under dam	....	17,000

Drilling and grouting for the cutoff curtain and drilling to provide relief of uplift pressures were performed by Government hired labor forces operating from the inspection gallery as the work on the dam progressed. Before placement of the concrete, the main-dam contractor set the necessary black steel pipe extending from the foundation rock to the gallery through which the drilling and grouting were performed.

It was found that, in drilling and grouting from the gallery, numerous moves of equipment would be involved. The weight of the drills precluded movement by hand power and the preset drill casing extending above the gallery floor would interfere with the movement of skid-mounted drills. Therefore a monorail was designed and installed in the roof of the gallery to facilitate handling of the equipment. A length of 1,008 ft of monorail was initially installed. This could be easily removed in sections and reinstalled as the work advanced. As a result of this innovation the work has been expedited, costs reduced, and safety improved.

During drilling in the gallery, records and studies for improvement in the design of diamond bits and core barrels were made in continuation of similar studies initiated in 1948 in cooperation with manufacturers of various types of diamond bits. As a result, several improvements in design of bits, both coring and noncoring, were made. These improvements have effected important economies in this type of drilling.

Two Classes of Mass Concrete

Mass concrete in the dam was divided into interior and exterior classes. The former, proportioned on the basis of 2.5 bags of cement and 8.5 gal of water per cu yd (water-cement ratio not exceeding 0.75), was used throughout the interior of the dam. The latter, proportioned on the basis of 4 bags of cement and 6 gal of water per cu yd (water-cement ratio not exceeding 0.52), was placed on the upstream and downstream faces of the dam for an average depth of 6 ft, and around penstocks, conduits, etc.

Portland cement having a moderate heat of hydration and low alkali content was blended with a natural cement containing an interground air-entraining agent on the basis of about 75 percent portland to about 25 percent natural cement. Air-entrainment content varied from 5 to 6 percent.

The cement was shipped by rail and delivered to the contractor at Cotter. Thence the contractor moved it over the access railroad to the dam site, where it was pneumatically off-loaded into silos for transfer by covered conveyor to mixers.

Concrete aggregates were manufactured from a limestone quarry on Lee Mountain located about 7 miles from the dam site in a westerly direction. The contract involved quarrying and delivering acceptable raw aggregate to a processing plant on the north abutment at the dam site, crushing and screening into the various specified sizes, and stockpiling the finished product over re-

AGGREGATES FOR DAM were manufactured at quarry on Lee Mountain by Flippin Materials Co. Maximum height of quarry face was 80 ft. Rock was shovel loaded, delivered by truck to crushers, reduced to 6-in. size, cleaned and stockpiled. Delivery to dam, 7 miles distant, was by conveyor belt.

claiming tunnels installed by the Ozark Dam Constructors. When production of concrete aggregates had been completed for the main dam, production continued for the powerhouse. A total of 2,885,000 tons of coarse and 945,000 tons of fine aggregates were produced for both structures. The product, crushed and screened to 6-in. minus size, was delivered by a 7-mile-long belt conveyor to the dam site for processing.

The material, as received from the quarry, contained the required sizes of coarse aggregates in the approximate proportions needed in the concrete. Therefore the production of the required four sizes—6 to 3 in., 3 to $1^1/_2$ in., $1^1/_2$ to $^3/_4$ in., and $^3/_4$ in. to No. 4—was essentially a screening process. Any unbalance in the gradation was corrected by use of a cone crusher. This crusher also reduced the remainder of the raw aggregate to minus $1^1/_2$ in., which was stockpiled for the manufacture of sand.

This material was reclaimed, passed through hammermills and impactors, and conveyed to screens varying in size from No. 4 to No. 16. The product was then passed through an air separator plant where all objectionable fines were removed and the finished sand delivered to a shuttle conveyor which distributed it in thin layers to a stockpile over twin reclaiming tunnels equipped with multiple gates. This combination of distribution and multiple gates resulted in a more uniformly graded sand for delivery to the mixers. As the sand was produced by the dry process, all operations were necessarily housed and weatherproof. The operation produced a serious dust problem, necessitating the installation of electrically driven dust collectors and disposal system.

Cooling of Aggregates

The specifications required that concrete be placed at temperatures not exceeding 65 deg F, as one of several measures to prevent cracks. To accomplish this, the Ozark Dam Constructors developed a method of cooling the coarse aggregate by inundation in circulating precooled water at a temperature of 35 deg F. Two steel cylindrical silos were provided for each size of aggregate, installed symmetrically along each side of a conveyor belt leading from the reclaiming tunnel. The aggregates were discharged onto a shuttle conveyor which in turn discharged into each of the eight silos. After inundation the aggregates were drained, freed of excess water by vibrating screens equipped with air-water jets, passed into a collecting hopper, and thence to the mixing-plant batchers. The air-water jets consisted of a number of small-diameter perforated pipes mounted transversely over the screens. It was found that the concrete could be placed at temperatures not exceeding 65 deg F without cooling the sand.

To maintain the low temperature of the aggregates until they were delivered to the mixers, the cooling plant was housed and air-conditioned, and the conveyor to the batchers, as well as the batchers themselves, was inclosed and insulated.

The cooling plant had a total available refrigeration capacity of 1,689 tons at 40-lb suction pressure. Approximately 417 tons of this capacity were required for forced cooling of the concrete after placement, 900 tons for aggregate cooling, and the remainder of 372 tons for air-conditioning, unpredictable losses, and standby. The cooling plant was designed to provide for the peak output of the batching plant, which was 320 cu yd per hour.

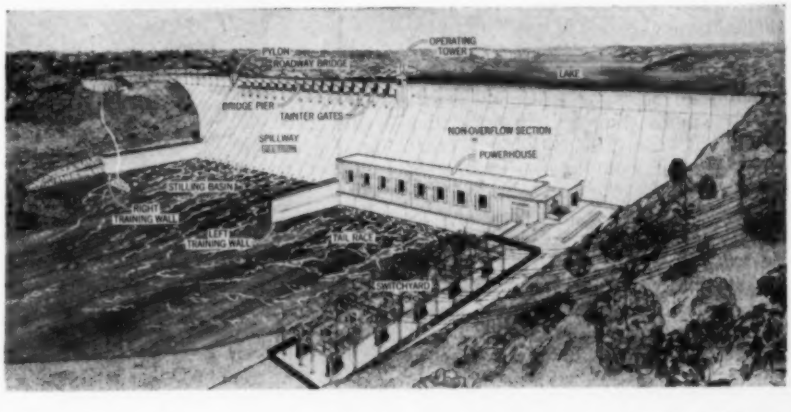
Concrete Mixing and Placing

Concrete was mixed by four 4-cu yd, 3-blade, tilt-type mixers, each equipped with a consistency meter. The concrete was delivered to points of placement by five trains, each consisting of one flatcar with four 4-cu yd buckets and space for a spare, and hauled by a diesel dinkey. Each train was one-man operated by remote control. Placement in forms was by two hammerhead and two gantry cranes mounted on a 170-ft-high steel trestle spanning the dam and located 125 ft downstream from the axis. The timber-decked trestle carried standard-gage tracks between the 38-ft-gage tracks on which the cranes operated. Highest monthly concrete placement was 168,000 cu yd, in August 1950.

Bull Shoals Project

Drainage area above dam, sq miles	6,036
Average annual stream flow, cfs	6,400
Maximum flood of record, cfs	240,000
Height of dam above foundation, maximum, ft	285
Crest length, ft	2,256
Total concrete, cu yd	2,100,000
Total reinforcing steel, lb	9,524,300
Net length of spillway, ft	680
Number of radial crest gates (size 40 x 28 ft)	17
Maximum spillway discharge, cfs (El. 703)	545,000
Number of discharge conduits (size 4 x 9 ft)	16
Controlling capacity of discharge conduits, cfs (El. 654)	53,000
Number of penstocks (18-ft diameter)	8
Total storage capacity (acre-ft)	5,408,000
Storage for flood control (acre-ft)	2,360,000
Gross head, power pool full, ft	198
Area of reservoir, flood pool, acres	71,200
Number of turbines to be installed (4 initially)	8
Rated best gate capacity of each turbine at 190-ft head, hp	52,000
Generator rating, at 0.95 power factor, kva	42,100
Average annual potential energy output, kwhr	685,000,000

STAGE 3 of project, with dam and powerhouse completed, includes installation of first four power units. Turbines are Francis type, with 65,500 hp at net effective head of 197 ft. Each generator will have normal rating of 40,000 kw at 0.95 power factor.



The 25 square, bottom-dump concrete buckets were built especially for the job and designed to give rapid and complete discharge without segregation. With the exception of leveling foundation lifts and other special areas where wooden forms were used, forms for the concrete monoliths were standard steel cantilever type, held in place by anchors embedded in previously placed concrete. These forms were raised for each succeeding lift by special form jacks. A type of absorptive form lining known as hydron was used on all faces exposed to weathering and running water.

As a crack preventive measure, the mass concrete in the dam was artificially cooled after placement to reduce temperature differentials, thus reducing thermal stresses in areas of high restraint. For this purpose refrigerated water was pumped through 1-in.-dia, thin-wall pipes embedded in concrete on foundation rock and thereafter between each succeeding lift of concrete. A total of 728,950 lin ft of cooling pipe was installed, through which 71,000,000 gal of refrigerated water was circulated.

Reservoir Clearing and Relocations

Reservoir clearing is now being performed by three separate contracts, and is scheduled for completion by January 1952. It involves clearing of about 25,000 acres between El. 654, top of power pool, and El. 620, except in recreational areas where it is cleared to El. 590. In the area below El. 620, the clearing includes topping of all trees which extend above El. 620.

Relocations involved removal of 3,200 graves from 52 cemeteries and reburial in 12 new cemeteries under 10 separate contracts. The construction of 21 miles of state highways, including 5,200 lin ft of bridges, 50 miles of county roads, and 35 miles of utility lines, and replacement of roads and utilities in several affected towns, are being performed by the respective owners under negotiated contracts scheduled for completion by June 1953.

The dam was completed in October 1951 and the power plant is scheduled for completion in November 1952 with the first generating unit in operation in June 1952. The estimated total cost of the completed project is $76,300,000.

The project was designed and is being constructed under the supervision of the Little Rock District, Corps of Engineers, Department of the Army. Harvey Slocum is Project Superintendent for the contractors in constructing the dam and powerhouse and furnishing aggregates.

A contractor assays

NOW THAT Bull Shoals Dam is practically completed, it will be of value to record the actual cost of certain requirements of the plans and specifications and in some cases to suggest methods by which such costs can be reduced or eliminated on further projects.

Bull Shoals Dam is a U.S. Corps of Engineers project on the White River in northern Arkansas. This gravity concrete structure has a maximum height of about 260 ft, and a length of 2,254 ft. It has required a total of slightly over two million cubic yards of concrete.

Care and Diversion of River. In the 23 years of record, the White River at the site has had a maximum flow of 240,000 cfs. In that period, it has exceeded 150,000 cfs only four times. The specifications required a cofferdam which would divert 150,000 cfs without overtopping. This requirement meant a long cofferdam about 40 ft high in the first stage, and another almost as long and 60 ft high in the second stage. Since

USE of distant quarry and manufactured sand for Bull Shoals Dam aggregates added estimated $4,250,000 to cost as compared to use of natural sand and nearby quarry. Seven-mile-long conveyor belt carried crusher products to dam site. Belt, made by Goodyear Tire & Rubber Co., traveled on idlers manufactured by Hewitt-Robbins, Inc.

the specifications for Bull Shoals Dam

ROSS WHITE, M. ASCE, Vice-President, Brown & Root, Inc., Houston, Tex.

the dam is of mass concrete, founded on a good grade of limestone, overtopping would not have damaged the permanent structure and would have caused only a minor delay. It would have been far cheaper to permit a much lower cofferdam, and face the possibility of occasional overtopping.

An even greater saving on cofferdamming would have been possible if, in designing the spillway, two nonadjacent monoliths had been left free of gates or other structures so that they could be left low for passage of the river flow during the second stage. Such passage of river flow could have been accomplished in several ways, the simplest being the entire omission of the four gates in the two blocks, if the required release capacity permitted. If the release capacity would not permit this arrangement, the remaining twelve gates could have been increased in size to provide the same capacity, or the spillway section could have been made longer to provide the same capacity.

Cost of care and diversion of the river was more than $1,500,000. Provisions such as those outlined would have reduced this cost by at least $500,000, with all hazards of overtopping carried by the contractor.

Height Differential Limited to 20 Ft. Another paragraph of the specifications limited the difference of height between monoliths to 20 ft. This seemingly harmless requirement was probably one of the more expensive items in the contract, as it affected construction costs in many ways. To permit full use of the low blocks suggested for the river diversion, it would have had to be waived. It forced a complete shutdown of concreting operations for the three months required for second-stage diversion, and slowed concreting progress during the four months required to bring the concrete in the second-stage area to the elevation of the first-stage concrete. This one requirement lengthened the construction period by not less than six months and increased overhead and other costs by at least $500,000.

Concrete Lifts Limited to 2½ Ft. The specifications required that, on rock foundations and on any concrete more than 15 days old, the concrete be poured in lifts not more than 30 in. deep until 10 ft of concrete had been placed. Cleanup and curing costs were exactly the same per square foot of area for a 30-in. lift as for a 5-ft lift. As nearly as can be determined, this requirement increased the cost of Bull Shoals Dam by not less than $300,000.

Five-Day Limit Between Successive Lifts. Bull Shoals Dam specifications required a lapse of five days between lifts on the dam, as compared with the three-day interval frequently used. It is estimated that three months of added construction time was required to carry out this specification—at an additional cost of not less than $250,000.

Refrigeration. Specifications required that concrete be cooled before, during, and after placement. Actual cost records of the contractor show that providing this cooling cost slightly over $1,400,000.

Aggregate. Bids for construction of Bull Shoals Dam were taken twice—first on June 27, 1946, and again on May 1, 1947. Award of contract was actually made on the basis of the June 27, 1946, bid, but before the contract could be signed, an Executive Order was issued which prohibited any further contract commitments. Before this prohibition was lifted, so much time had elapsed that it was mutually agreed to cancel the previous award and to readvertise. On this second letting, May 1, 1947, the contract was awarded under which the dam has been built.

Under the first award, fine aggregate was to have been natural sand from bars on the White River and a tributary creek, and coarse aggregate was to have come from a limestone quarry just downstream from the dam. Under the second award, all aggregates have come from a limestone quarry seven miles distant, with the sand or fine aggregate produced by grinding the crushed rock from the same quarry.

The writer's firm was a member of the joint venture which submitted the low bid on both the dam lettings, and also of the joint venture which was low bidder on the contract for supplying aggregate for the dam as built. Under these circumstances, it has been possible to determine rather accurately how much more Bull Shoals Dam has cost because of the decision to abandon natural sand and a nearby quarry for manufactured sand and a distant quarry. Careful analysis of bid figures, and of actual production costs show that the aggregates for Bull Shoals Dam actually have cost more than $4,250,000 in excess of the sum they would have cost if obtained from the sources originally contemplated.

It is perhaps pertinent to point out that *if* surface deterioration had occurred as a result of using nearby materials, a lot of patching could be done for four million dollars—even more, if the hypothetical repairs were not needed for 25 years, when today's savings, capitalized, would have doubled.

The items that have been discussed add up to a possible saving of $7,200,000. Of this amount, $2,450,000 or more is chargeable to costs incurred to minimize cracking. Many dams of equal height, built without these costly restrictions, are standing up and serving their purpose just as well as Bull Shoals can ever do.

Reappraisal of flood control indicated by Midwest flood

FAIRFAX INDUSTRIAL DISTRICT, Kansas City, Kans., although protected by high levees, was flooded July 14, 1951, by failure of a drainage structure after flood crest had passed. This district, one of most modern in nation, contains automobile assembly plants, oil refineries, airline repair headquarters, and farm machinery distribution centers. Stored Government property alone suffered damage of a million dollars.

ON FRIDAY, the thirteenth of July 1951, Mother Nature billed the occupants of Midwestern river valleys for the rental she exacts for their occupancy. The bill was in the form of record-breaking floods in the Kansas, Marais des Cygnes (Osage), Neosho, Verdigris and Missouri River basins. President Truman, in his message of August 21, 1951, to Congress summarized the cost as follows: a billion dollar physical damage and an equal amount in loss of income; 30 to 40 thousand homes flooded, 15 thousand of which were damaged seriously or totally destroyed; 20 thousand people displaced; and 30 thousand farms flooded. Since the date of this message, additional details have been reported.

Nevertheless, this picture of destruction and suffering has not improved. The flood-stricken area developed the slogan, "This must never happen again." In this slogan there is unity of objective but methods of attainment differ. These differing methods involve: (1) retention of precipitation where it falls, (2) large flood control reservoirs and levees; (3) permanent evacuation of residences and industries from the flood plain, (4) and flood insurance. Presumably no single one of these plans can fully accomplish the objective. All must be analyzed and weighed in order that the program may be developed within the limits of economic and social justification. Every phase, from soil conservation to power generation, should be integrated into a balanced plan. Preliminary analysis of the mass of excellent hydrologic data which is becoming available as a result of the storm and disaster indicates that all previous plans and designs should be reviewed.

AMERICAN ROYAL Stock Show buildings in Kansas City, Mo., were submerged to tops of box cars. Interruption of service at Turkey Creek pumping station, in right foreground, handicapped fire fighting on Southwest Boulevard.

Hydrologic Data Analyzed

Historically this is the third major flood recorded in the area. Only legendary information is available for the terrific overflow of 1844. Very limited rainfall, river-stage and stream-flow data were recorded for the flood of May 1903. For the 1951 flood, records from over 400 rainfall and 100 stream-flow stations are available for analysis. In addition, the results of over 900 unofficial rainfall observations were collected through the coordinated efforts of the Weather Bureau and the Corps of Engineers. The U. S. Geological Survey and the Corps of Engineers supplemented stream-flow data by

objectives of July 1951

VERNE ALEXANDER, M. ASCE

North Central Area Hydrologic Engineer, U.S. Weather Bureau, Kansas City, Mo.

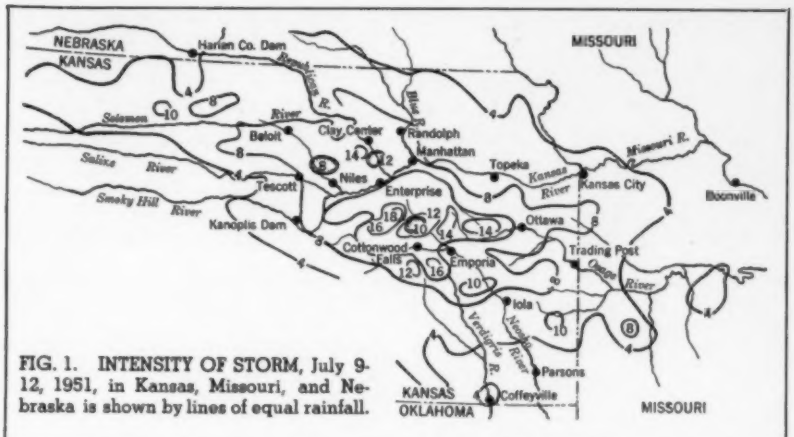


FIG. 1. INTENSITY OF STORM, July 9-12, 1951, in Kansas, Missouri, and Nebraska is shown by lines of equal rainfall.

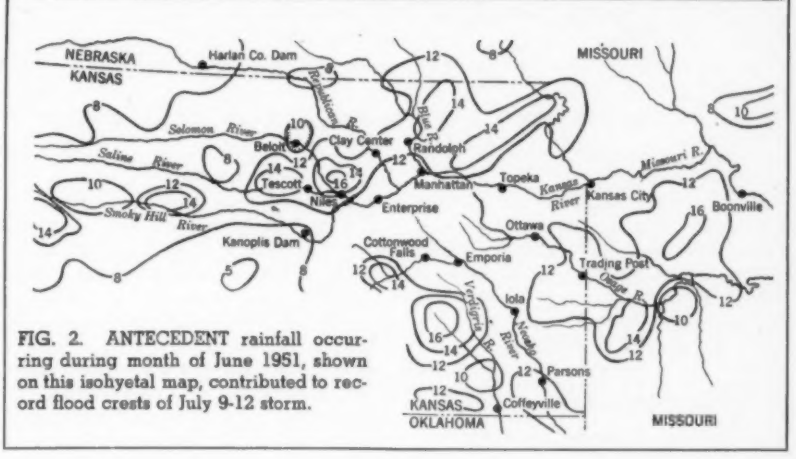


FIG. 2. ANTECEDENT rainfall occurring during month of June 1951, shown on this isohyetal map, contributed to record flood crests of July 9-12 storm.

making slope-area determinations of flow at ungaged points. It will be several months before all this information is fully analyzed and released in official reports. Most of the rainfall data have been processed and released by the Weather Bureau, and it is now possible to define the limits and magnitude of the storm and compare it with others.

An isohyetal map for the period July 9–12, 1951 (Fig. 1), shows the distribution of rainfall over the area. Mass rainfall accumulation curves, Fig. 2, indicate approximate rates of precipitation for key areas, but these do not necessarily represent the exact area average. The main storm center was near the divide between three basins—the Osage, Kansas and Neosho. From a meteorological viewpoint, if this center had occurred 75 miles further northwest, 40 percent more precipitation would have been added to the Kansas Basin.

There are other significant factors. The average rainfall in the state of Kansas in June, preceding the excessive amounts of July, was 9.55 in. or 240 percent of normal (Fig. 3). This is important because of storage requirements in existing or proposed reservoirs in the upper basins. On July 5–6, just four days prior to the period of excessive rainfall which produced the crest, the Lower Missouri Basin received torrential rains. Official gages at Lexington and Henrietta, Mo., recorded approximately 14 in. in 12 hours. The Missouri and Mississippi between these points and Cairo, Ill., were flooding seriously. No doubt this fact alone would have complicated the operation of upstream reservoirs had they been completed.

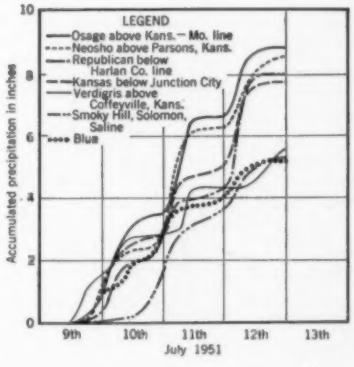


FIG. 3. COMPOSITE mass rainfall curves for flood of July 9-12, 1951, on watersheds in Kansas, Missouri, and Nebraska, are each based on six key stations.

Comparisons with Other Storms

A comparison with other major storms that have occurred in the Midwest since 1895 is shown in Table I. These data are shown for the 72-consecutive-hour periods having the maximum rainfall during the storms. For a graphical comparison of the storms tabulated in Table I, see Fig. 4. The 1951 storm is the greatest ever observed north of the 37° parallel. Two other major storms in the list may be of special

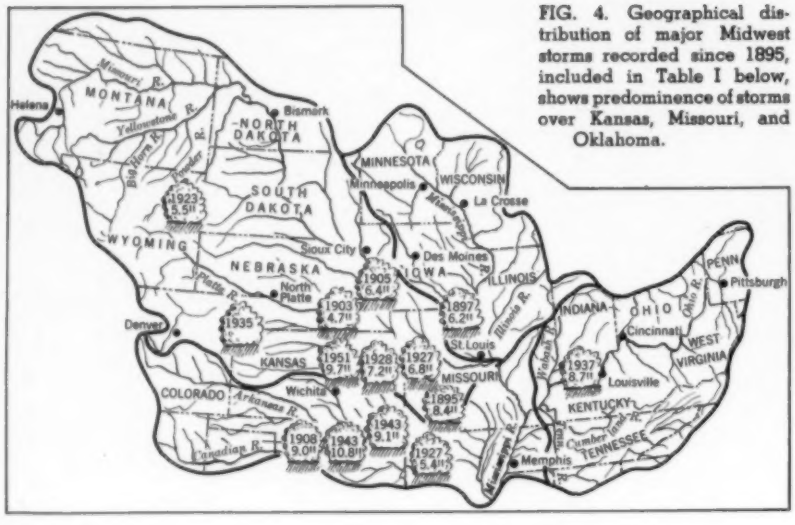


FIG. 4. Geographical distribution of major Midwest storms recorded since 1895, included in Table I below, shows predominence of storms over Kansas, Missouri, and Oklahoma.

FLOOD CRESTED at Cape Girardeau, Mo., 600 miles downstream from storm center, at 41.8 ft on July 24. Frisco Railroad Station was inundated. Note highway bridge over Mississippi River in background.

TABLE I. MAJOR MIDWEST STORMS—MAXIMUM DEPTH OF 72-HOUR RAINFALL, IN INCHES

Date	Storm Center	Storm Area, in Square Miles							
		10	100	1,000	5,000	10,000	20,000	50,000	100,000
Dec. 16–20, 1895	Phillipsburg, Mo.	12.2	11.8	11.1	10.1	9.3	8.4	7.1	5.7
Dec. 31, 1896–Jan. 3, 1897	Warrenton, Mo.	9.1	8.8	8.0	7.1	6.7	6.2	5.5	4.8
May 25–June 1, 1903*	Abilene, Kans.	10.7	10.6	9.5	6.8	5.6	4.7	3.7	2.9
Sept. 12–19, 1905	Thurman, Iowa	11.9	11.5	10.5	8.9	7.8	6.4	4.7	..
Oct. 19–24, 1908	Meeker, Okla.	15.2	14.9	13.7	11.7	10.6	9.0	6.6	..
Sept. 27–Oct. 1, 1923	Savageton, Wyo.	16.9	15.9	11.8	7.6	6.3	5.5	4.3	..
May 30–31, 1935†	Burlington, Colo.	22.2	15.4	7.2	4.0	..	..	..	..
Apr. 17–21, 1927	Story, Ark.	12.5	12.3	10.8	8.1	6.6	5.4	2.9	..
Sept. 28–Oct. 2, 1927	Pleasanton, Kans.	12.9	12.4	11.2	8.9	7.8	6.8	5.5	4.4
Nov. 15–17, 1928‡	Lebo, Kans.	11.2	10.6	10.1	9.1	8.3	7.2	5.4	..
Jan. 5–25, 1937	St. John, Ky.	11.2	11.1	10.7	9.6	9.2	8.7	7.6	6.2
May 6–12, 1943	Warner, Okla.	24.9	22.5	18.0	14.4	12.6	10.8	8.3	6.4
May 13–20, 1943	Commerce, Okla.	16.7	15.4	13.8	12.1	10.7	9.1	7.0	5.4
July 9–12, 1951*	Herington, Kans.	18.0	17.0	15.5	13.3	11.6	9.7	6.8	4.8
Maximum in United States		37.6§	35.2‖	32.2‖	24.4¶	21.3¶	17.6¶	11.5**	8.9**

* Provisional estimate
† 24-hour storm
‡ 60-hour storm
§ Thrall, Tex., Sept. 8–10, 1921
‖ Miller Island, La., Aug. 6–9, 1940
¶ Hearne, Tex., June 27–July 1, 1899
** Bonifay, Fla., July 5–10, 1916

TABLE II. HIGHEST FLOOD-CREST STAGES ON MIDWEST RIVERS

River	Station	Bank-Full Stage	July 1951 Crest		Previous High	
			Stage	Date	Stage	Date
Kansas	Manhattan	17	35.5	13	28.0	6/4/35
	Topeka	21	36.4	13	32.7	5/30/03
Smoky Hill	Enterprise	26	33.9	14	32.0	5/–/03
	Salina	20	24.1	13	24.6	5/30/03
Saline	Tescott	25	30.2	13	29.8	6/9/51
Solomon	Beloit	20	39.3	13	35.9	6/11/41
	Niles	24	32.0	14	32.3	6/3/03
Republican	Clay Center	15	22.4	12	25.7	6/3/35
Big Blue	Randolph	22	29.1	13	30.8	6/10/41
Osage	Ottawa	24	42.1	12	37.6	11/17/28
	Trading Post	24	38.1	14	34.4	11/18/28
Cottonwood	Cottonwood Falls	9	19.8	11	15.7	7/20/48
	Emporia	20	33.3	11	29.5	7/20/48
Neosho	Iola	15	33.4	13	24.7	7/23/48
	Parsons	24	40.2	14	31.2	7/27/48
Missouri	Kansas City	22	36.2	14	35.0	6/2/03
	Boonville	21	32.8	17	32.7	6/21/1844
	Hermann	21	33.0	19	31.1	6/21/43
Mississippi	St. Louis	30	40.3	22	41.4	6/27/1844
	Cape Girardeau	32	41.8	24	42.5	7/4/1844
	Cairo	40	40.6	28	59.5	2/3/37

interest. The great flood of February 1937, in the Ohio Basin, was caused by recurrent precipitation during the period December 27, 1936, to January 25, 1937. The combined storms of May 1943, in Oklahoma, exceed everything of record; however, there was a three-day break in the over-all period.

Effect of Distribution on Peak Flows

The effects of storms on stream flow and the complexities of storm analysis and stage predictions are illustrated by a comparison of the 1903 storm and flood with that of 1951. These storms occurred in approximately the same area. From Table I it will be observed that the 1903 maximum 72-hour rainfall averaged 4.7 in. over 20,000 sq miles as compared to 9.7 in. over an equal area in 1951. The crest stage of the Missouri River at Kansas City, Mo., in 1903 was 35.0 ft and the peak flow has been reliably estimated as being 548,000 cfs. This may be compared with an observed crest of 36.2 ft in 1951 and 572,000 cfs measured by the U. S. Geological Survey.

Part of the explanation is found in two opposing factors which tend to balance. The 1903 storm area was slightly northeast of the 1951 area, just far enough to put approximately 50 percent of the runoff in the Missouri Basin and 50 percent in the Kansas Basin. In 1951, nearly 90 percent of the flow came down the Kansas River. The 1903 storm was of much longer duration. The maximum 168-hour average depths were: 16.8 in. for 10 sq miles; 16.3

SHIPPING INTERESTS estimated loss of 200,000 shipping-car days due to type of flood damage shown here. Depth and force of flood are evident from tangle of box cars it left behind.

PROXIMITY OF medium-prized residential districts to major industries has been considered valuable asset. In twenty areas similar to this, 15,000 homes suffered damage like that pictured.

CENTRAL Industrial District, Kansas City, Mo., was submerged in 20 ft of water, July 14, 1951. Loss of income from suspension of production and business alone in flood areas probably reached a billion dollars.

for 100; 14.2 for 1,000; 9.4 for 10,000; 8.2 for 20,000; 6.7 for 50,000; and 5.4 for 100,000. The Missouri drainage immediately above Kansas City has a shorter time of concentration of runoff, thereby synchronizing the flows to the extent that a 168-hour storm produced a peak flow quite comparable to a 72-hour storm in a slightly different area.

Other factors in the situation which affected the crests and peak flows were antecedent rainfall and the carrying capacity of the channel. In this case the antecedent rainfall conditions were comparable. In 1903, flows over the flood plain were more than a mile wide, and in 1951 they were confined by the North Kansas City levee system, which was not breached. Counteracting this restriction is the recently completed Liberty Bend cutoff, 14 miles downstream from Kansas City, which reduces the river mileage by about four miles.

Flood Caused Record River Stages

Record-breaking stages were experienced at all points on the Kansas River from Junction City to the mouth, and on the Missouri River from Kansas City to the mouth. In general, the legendary flood of 1844 is thought to have been from 1 to 3 ft higher in parts of this area. Perhaps the stages of the Neosho River in Kansas were the most outstanding. At Iola and Parsons the crest was approximately 9 ft higher than any previously known stage. Comparative data are given in more detail in Table II.

Crests throughout the Kansas Basin occurred almost simultaneously, or in some cases at downstream points before those nearer the headwaters. This was due to the distribution of rainfall. The peak flow on the Solomon River near the mouth occurred one day later than the crest at Manhattan, several miles downstream. The normal travel time from Manhattan to the Kansas City industrial district is approximately three days, but in this case the highest stages were observed at all points within a 24-hour period.

Preliminary determination of the runoff of the Marais des Cygnes (Osage) River at Ottawa, Kans., for the period July 9–18 puts it at about 675,000 acre-ft. The drainage area above Ottawa is 1,260 sq miles. This gives a runoff depth of slightly over 10 in. for the 10-day period. Two reservoirs are proposed for the area above Ottawa. (See "Work of the Corps of Engineers in Kansas," July 1, 1950, by Edward G. Daly, District Engineer, Tulsa, Okla.) These have a total storage capacity of 225,000 acre-ft and the drainage area above them is 674 sq miles. Rainfall over the basin was fairly uniform and, on the basis of drainage-area ratio, the total inflow to these two reservoirs would have been about 360,000 acre-ft.

Similarly, the flow of the Neosho River at Parsons, Kans., was 2,720,000 acre-ft for the period July 9–22, giving a runoff depth of 10.5 in. A reservoir system for the upstream area consisting of four units, having a total flood storage capacity of 478,000 acre-ft, was authorized by the Flood Control Act approved May 17, 1950. The drainage area above the downstream reservoir is 2,910 sq miles as compared to 4,820 above Parsons. On a straight ratio basis, the runoff into the four units would have been about 1,650,000 acre-ft. This estimate is extremely conservative, since the rainfall, as indicated by Fig. 1, was much heavier in the headwater area.

Role of Flood Forecasting

Out of the destruction, damage and suffering come obvious conclusions. A well-balanced flood management program involving headwater retention, large reservoirs and levees is essential. However, absolute protection is only an optimistic hope and cannot be economically justified. Full consideration should be given to flood-plain zoning for residential and industrial developments and an equitable flood insurance plan to cushion losses for home owners and small industries. If flood control is defined as the prevention of flood damage, then flood forecasting must be recognized as one method of flood control.

An analysis shows that flood-damage areas may be divided into three categories: (1) those in which the cost-to-benefit ratio obviously favors a public investment in control structures; (2) those in which the margin of benefit is so small as to render the cases questionable; and (3) those in which the cost-to-benefit analysis shows costs to exceed benefits. It is in connection with the last two categories that flood forecasting should be considered as an alternative method of attaining the flood control objective.

LAW

Liquidated damage clauses in contracts are not always valid

WALTER C. SADLER, M. ASCE, Civil Engineer and Attorney-at-Law, Ann Arbor, Mich.

LIQUIDATED DAMAGE is the agreed compensation for the breach of a contract. However, if the breach results in litigation, the plaintiff may not be able to collect compensation on the basis of the liquidated damage clause. The stipulated damage may be higher than the actual damage. For instance, a construction contract might specify the date of completion, with liquidated damages of $20 per day for each day's delay in completion. If the delay caused an actual damage of only $9.75 per day, the issue could be raised as to whether the plaintiff should receive this smaller sum instead of the contractual $20 per day. Each controversy must be analyzed on its own merits.

Penalty Clauses. The object of a penalty clause is to enforce performance. It is coercive, giving the contractor the option of completing the work under adverse conditions or paying a penalty. A penalty clause is an invitation to a lawsuit. Liquidated damage is designed, in part, to avoid such litigation. It is presumed to be a fair and reasonable measure of the injury resulting from a breach of contract, and is particularly useful when at the time the contract is signed there is difficulty in anticipating the extent of injury from a breach.

Since liquidated damage is compensation for an injury, its use as a penalty is void. For instance, a $3,600,000 engineering project might earn 4 percent net, or $144,000 per year. That would be $36,000 per quarter or $400 per day. If the liquidated damage clause in the contract provided $36,000 for each delay of "90 days or any fraction thereof," a charge of $36,000 for a one-day delay would be unreasonable and void. On the other hand, a charge of $400 for each day might be reasonable. The courts favor the per diem formula over the lump sum.

Wording. In preparing a contract, engineers have variously designated the compensation as liquidated damage, fine, penalty, forfeiture and demurrage. The use of any particular word may be indicative of punishment but is not conclusive. The issue turns upon the real purpose of the clause. If it is designed as a fair and reasonable compensation for injuries suffered, it is valid, but if the purpose is punishment, the clause is void.

Contracts often call for bids to be accompanied by certified checks, the contractor to forfeit his check if he does not sign the contract. For instance, a contractor bid $350,000, accidentally omitting a $50,000 item. He then refused to enter into a contract, and the city claimed the right to the entire $37,500 certified check. The court held that the $37,500 was merely a security, and refused either to order the check returned or to permit the city to keep it in full. A determination had to be made of the actual damage to the city, and the contractor reimbursed for the sum remaining out of his $37,500.

Intent. The legal analysis of a contract is determined by the intent of the parties at the time of the signing. The courts are unsympathetic with a party who has become sick of his bargain. On the other hand the court should not substitute its own concept of what would be a fair deal for each party.

If a liquidated damage clause borders on a penalty the intent becomes very important, for no business man would knowingly stick his neck into a noose. If the essential phases of a negotiated contract were discussed and bargained, then the contractor must have noted and accepted the liquidated damages as reasonable.

This is particularly true if the formula for damages represents an honest effort to measure the damages. A sum of $10 for each day's delay in completion of work would be a case in point, as would be $200 damages for each decrease of $1/10$ percent in the efficiency of a purchased machine of designated size. The writer of a liquidated damage clause should retain his original computations as evidence that he was contemplating a fair and reasonable compensation. Liquidated damages would be effective, for instance, for a late delivery against a dilatory borrower.

On the other hand, a contractor who has bid on a job containing a lump-sum damage provision has never had a chance to discuss the reasonableness of the sum. It was a case of taking the entire document "as is" or leaving it. For this reason probably, the courts usually treat liquidated damage clauses in lump-sum contracts as punishments and forfeitures, and let the owner carry the burden of proof that the clause is a reasonable measure of the injury, as estimated at the time of signing the contract. In negotiated contracts, the parties should take note of and discuss the liquidated damage clause.

Statutory Limitations. Some states limit the use of liquidated damage clauses to those situations where there is uncertainty as to the amount and extent of the potential injuries resulting from a breach. In opening a paragraph on liquidated damages, an engineer often formally states the difficulty in ascertaining the extent and amount of damages that would arise from a breach. This mere recital is not sufficient to validate a clause in those states that have statutory restrictions. The uncertainty must be real. The loss of use of land or buildings is easily ascertainable; likewise the loss in use of equipment where substitutes can be rented. A jury could also ascertain the value of an agent's time spent in attempting a sale.

On the other hand there would be uncertainty in the potential damage when a borrower pledges stock and equipment, the title to which is impaired by inheritance litigation. Even the strict California statute would enforce a liquidated damage clause in this case. When a wartime market contains no construction equipment, there would be uncertainty as to the extent of damages for the lost use of a machine.

Arctic engineering requires knowledge of permafrost behavior

G. W. RATHJENS, M. ASCE

Consulting Engineer, Berkeley, Calif.

ENGINEERING PROBLEMS in the Arctic, particularly in permafrost areas, are becoming more and more important. In the hope of helping engineers responsible for the accomplishment of specific missions in areas where permanently frozen materials occur close to the ground surface, Mr. Rathjens draws on his experience in successfully solving Arctic engineering problems. In his examples he explains the application of several basic principles governing design and construction in permafrost areas. His article is based on the paper he presented at the Hydraulics Division session during the Annual Convention in New York. This session, presided over by George H. Hickox, was sponsored by the Subcommittee on Permafrost of the Division's Joint Committee on Snow, Ice and Permafrost.

PERMAFROST is permanently frozen material. It may be bedrock, muck, sand, gravel, ice or some other superficial covering of the earth's surface which remains continually frozen for a period of two or more years. A permafrost area is a specific section where all or only a part of the material below the earth's surface is permafrost.

Permafrost may be present as a continuous stratum in varying thickness over great areas or it may exist as stringers, sheets, lenses or dikes separated from one another by stringers, sheets, lenses or dikes of permanently thawed material. Such thawed zones below the active layer, and in among the permafrost layers, are called taliks.

The presence of taliks may indicate treatment of an engineering problem quite different from that where no taliks are present. Taliks are the result of the *disciplines* of the area. The term *disciplines* as used here means all those factors on which the maintenance of temperature equilibrium depends in a given area, such as the amount of precipitation, ground water, wind, mean annual temperature, solar radiation, and character and compaction of materials.

The temperature and depth of permafrost vary widely over the earth's surface. I have worked in areas where the known temperature of the permafrost varied from 32 to 15 deg F and where its depth varied from a few feet to a thousand feet. In Siberia permafrost has been reported at a depth of two thousand feet. The data in Table I make it evident that some engineering problems may require entirely different, and possibly much more complicated treatment, in the Fairbanks area than in the Barrow area. In the Barrow area, at a depth of 2 ft, with the protection of the natural cover available, the temperature of the subsurface materials never rises above 32 deg F, whereas in the Fairbanks area the temperature at a depth of 2 ft has been found to vary from 27 to 45 deg F.

The relationship between the mean annual temperature of the air and the mean annual temperature of the ground at 8 ft below the surface is quite different when the former is less than 30 deg F than when it is greater than about 30 deg F. This difference is indicated by comparing the isotherms given in Fig. 1, taken from the report of the Committee on Sanitary Engineering and Environment to the National Research Council. Note that the isotherms on both maps correspond almost perfectly in the 30-, 35-, 40- and 45-deg range, whereas there is no correspondence in the 10-, 15-, 20-, and 25-deg range.

In solving any design or construction problem in a permafrost area, one of the first decisions the engineer must make is whether to disturb some of the permafrost or to keep it undisturbed. To upset the equilibrium that nature has established in a permafrost area is a very serious matter. The effect of such a change can only be forecast after a careful study of all existing factors and disciplines, many of which are interrelated.

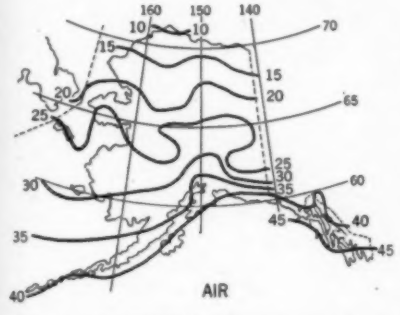
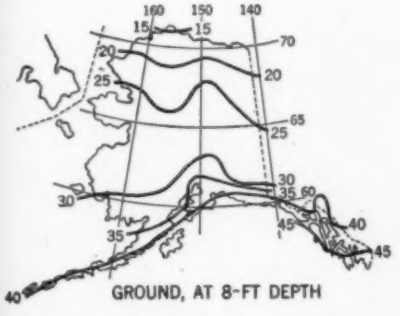


FIG. 1. ISOTHERMS of mean annual air temperature in Alaska (above) coincide with those for ground temperature at 8 ft below surface (below) only where mean annual air temperatures are above 30 deg F.



Problem 1. Diversion Dam Founded on Augmented Permafrost

A field investigation preparatory to the design and construction of the diversion dam shown in the photographs indicated that a relatively large amount of water was moving through the gravels in the river bed and its vicinity. The packing and grading of these gravels varied to a considerable extent in different parts of the proposed dam site.

The temperature of the water at the point of diversion varied from 32 to 36 deg F. This temperature was an important factor since the water was to be used as a medium for thawing permanently frozen gravels near the downstream end of the project. In designing the canal and siphons to transport the water diverted by the dam, certain economic hydraulic advantages were sacrificed to secure maximum exposure to the sun. This was considered advantageous so that the water delivered to points nearly 100 miles distant would have the highest practicable temperature.

The water moving below the surface of the gravels was of real value since estimates for the project indicated that approximately 125 cfs, plus seepage, evaporation and other losses, would be required to make the project feasible. Studies also showed that the runoff of the river at the proposed dam site varied greatly. The meager records available indicated that in dry years considerably less than the amount of water required to make the project feasible was available from surface runoff, while at flood time in wet years many times the amount it was proposed to divert was flowing in the river. Pondage of water as practiced in the temperate zones was not practicable.

Bedrock, a schist with quartz stringers in which the schist was somewhat decomposed for a depth of a few feet, was approximately 15 to 20 ft below the river bed. Ice formed on a bar in the river below the water surface near the site of the dam, as shown in one of the photographs. This ice indicated that some of the bedrock at the diversion site below the sand and gravels was permanently frozen. Investigation showed that the bedrock was frozen except the decomposed parts at the contact between the rock and the superimposed sands and gravels through which the water was moving.

Solution. Because of the shortage of surface water in dry years it was decided to intercept the water moving in the gravels at the dam site. This subsurface water was of value both because of its volume and because in the late fall, when the days are short and the air cold, it is warmer than the surface water. To conserve this water by sealing off its flow in the gravels would mean that permafrost in the thawed parts of the bedrock and gravels at the dam site would grow in extent. It was believed that such aggradation of permafrost might cause damage to a concrete structure because of the difficulty of maintaining a proper seal with the frozen bedrock. Therefore the subsurface water was intercepted by driving interlocking steel sheetpiling well into the bedrock. Wooden piling also was driven to support the timber superstructure of the dam.

The connection between this superstructure and the steel sheetpiling cutoff was so constructed as to allow differential movement to take place without serious damage to the structure. Such movement could result from heaving before proper adfreeze could be developed through aggradation of the permafrost in the materials surrounding the piling. The adfreeze strength of frozen ground is the resistance to the force required to move or pull apart the frozen ground from an object to which it is frozen. Adfreeze varies with temperature, packing and the characteristics of the materials.

This structure was completed in 1927 and has proved satisfactory. Repairs have been fewer than anticipated. Each winter the entire structure is covered with ice and a great part of the pondage behind the dam is ice. The dam is 800 ft long, and the weir has a length of 100 ft. The actual cost of the dam as built was approximately half the estimated cost of a concrete structure.

Principles. In the design and construction of this dam, the aggradation of permafrost was used to help solve an engineering problem economically. The aggradation of permafrost was brought about by (1) changing the packing of the thawed materials by driving piles into them, and (2) interfering with the movement of water in the gravels, sands, and thawed parts of the bedrock, thus bringing about a change in the local pattern of heat transfer.

Problem 2. Oil-Well Derrick Founded on Permafrost

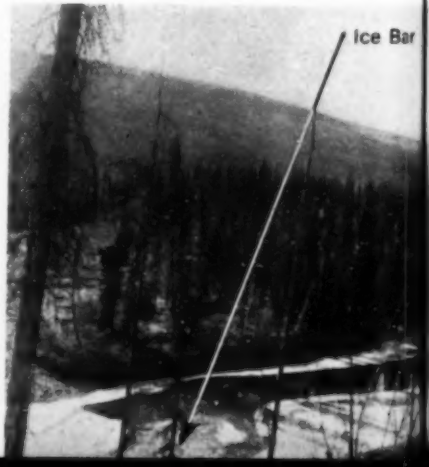
In designing a foundation to support the drilling rig for a rather deep oil well in a permafrost area, the decision was made to maintain the permafrost and use it to its maximum practicable value as a structural material. Here the permafrost extended from a few inches below the surface to an estimated depth of over 900 ft. Between the surface and a depth of about 20 ft below the surface, the materials consisted of some ice lenses, sand, and clay.

It was realized that the flow of drilling mud from the well would be a source of heat and would tend

TABLE I. ANNUAL MAXIMUM AND MINIMUM AIR, SNOW AND SOIL TEMPERATURES

At Fairbanks and Point Barrow, Alaska, 1947–1948, in deg F, from U. S. Weather Bureau Records

	Fairbanks		Point Barrow	
	Max.	Min.	Max.	Min.
Air	90	−59	70	−48
Snow	..	−56	..	−46
0.0 to 0.1 ft below surface	74	11	64	−13
2 ft below surface	45	27	32	0
10 to 11 ft below surface	35	30	21	10



DIVERSION DAM 800 ft long with 100-ft spillway, built in 1927 (lower left), was constructed by driving steel sheetpile cutoff (indicated by white arrow at bottom of upper photo) to bedrock to intercept underflow, and by driving wood piles into gravel to support superstructure and increase compaction. Ice bar found near dam site (indicated in photograph at right) resulted from permafrost.

to thaw the permafrost and destroy its supporting power. Mud temperatures would vary with the depth of the well and the rate of drilling but would be in the vicinity of 110 deg F.

Solution. In designing this foundation, a plan was developed by which a very limited part of the material surrounding the casing would be thawed, and this thawed material would be confined by the surrounding permafrost and used for its structural and insulating qualities. First, hollow steel piles were set, not driven, in previously thawed holes and permitted to back-freeze. The function of these piles was to transfer the weight of the drilling rig to undisturbed permafrost. These piles, acting as end-supported columns, transferred the loads through the adfreeze of permafrost which was developed on the lower part of the piling. A laboratory was set up in the field and studies were made of adfreeze values at different temperatures for the materials with which we were working. The values arrived at in this laboratory were used in the design.

Refrigerating wells and wells for temperature readings were also put down at various locations so that the conditions developed in the foundations could be watched, studied and controlled. Temperature readings were taken at various depths down to 195 ft, usually at 5-ft intervals, and were recorded for over a year. These measurements were made only a few days apart at first, and later whenever it was thought advisable to observe the progress of the thaw and refrigeration.

To control the thaw and maintain the permafrost, a certain amount of refrigeration was required. The total degree-days of cold available in the area was determined by graphical integration from graphs similar to Fig. 2. During the winter sufficient cold to maintain critical sections in a frozen condition throughout the year was stored in predetermined sections of the permafrost by using circulating oil as a refrigerating agent. The oil was circulated in the hollow piles and refrigerating wells. It was estimated that during the month of January, when the average ambient air temperature was −5 deg F, 18 tons of refrigerant was circulated during each 24 hours, some of this cold being stored in the permafrost. In this way the boundaries of the thawed zone were satisfactorily maintained throughout the year.

Principles. In this case, the inadequacy of the data and the difficulty of obtaining proper data in time for the most economical design, made it necessary to provide means of securing ample warning of difficulties that might arise in the course of the work. By providing such means it was possible to avoid overdesign, which otherwise would have been necessary. Such precautions will be essential to economical engineering design in the Arctic until such time as more data and experience are available to practicing engineers.

Problem 3. Permafrost Supports Steam Power Plant

In 1926, near Fairbanks, a site was selected and excavation commenced for a 6,500-kva steam power plant on what appeared, after exploratory drilling, to be thawed gravels. As the excavation work progressed it became evident that only a part of the gravel formation was thawed, and that the site was located on a very large kidney of dry permafrost. An appreciable amount of water was moving past this kidney, the water having a measurable gradient. The gravels and sands comprising the kidney were relatively closely packed as compared with the materials adjacent to the kidney through which the water was moving.

Solution. During the design of the plant serious thought was given to the advisability of driving piling into the thawed sands and gravels immediately above the kidney and, if practicable, into the frozen sands and gravels comprising the kidney itself. After a careful field investigation it was decided not to drive any piling, but rather to redesign the foundation structure and use the materials in place, almost as they were, to carry the load.

Provision was made to thaw a part of the dry permafrost in the center of the kidney and to use the thawed, confined sands and gravels to support and distribute the load to the permanently frozen materials of the kidney which surrounded them on all four sides and below. The thawed area extended about 100 ft further in each horizontal direction than the size of the structure, and about 30 ft deeper than the power plant foundation proper.

Thawing the sands and gravels in this manner provided for their confinement by permanently frozen materials. Because of the many uncertainties connected with this foundation and the pioneering involved, a temperature hole was put down near each corner of the power plant and temperatures were carefully watched. In addition, provision was made in the design of the structure so that any movement of the foundations would be reflected at known locations. I personally inspected these indicators each year for a period of over 15 years. The power plant has been operating satisfactorily for over 20 years and to date there has been no indication of any foundation trouble.

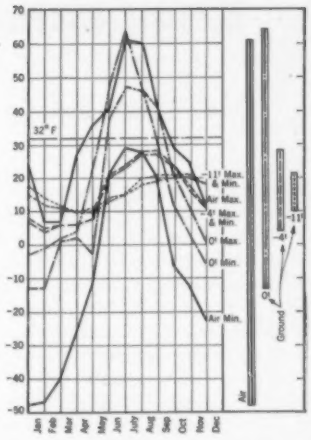
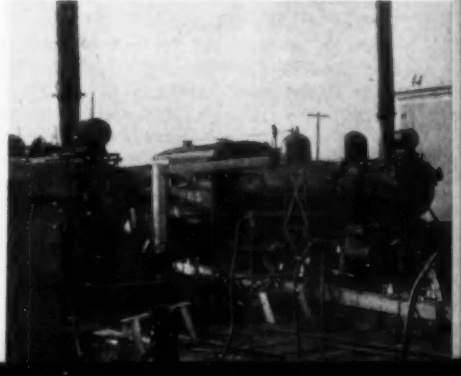


FIG. 2. RECORDS of monthly extremes in air and ground temperatures at Point Barrow, Alaska, 1947, are plotted to determine degree-days of cold available for refrigerating permafrost during well drilling operations.

Principles. Had piling been driven or explosives used in this excavation according to ordinary practice in the temperate zone, foundation troubles would have been much more likely to develop than with the method used. To disturb parts of the permafrost kidney so that live ground water could move through the fractured zones might have caused thawing of the surrounding frozen materials, accompanied by continuous serious settlement over a number of years.

TWO LOCOMOTIVE BOILERS provided heat to thaw out permafrost to depth of 30 ft below and to horizontal distance of 100 ft out from foundations of Alaskan steam power plant. Thawed sands and gravels confined entirely by permafrost have supported plant for 20 years without foundation trouble.



Engineers called on to defend competitive

President's Inaugural Address at 99th Annual Convention of ASCE

NO GREATER honor, privilege, or opportunity can come to an engineer than election to the presidency of this oldest of national organizations of engineers, the parent society of all civilian branches of the profession. To attain this high privilege and to serve during the year of the celebration of our Centennial is an honor and an obligation that gives me a deep sense of humility, of grateful appreciation, and a full awareness of the magnitude of the job ahead.

The importance of this year, with its celebrations, culminating in our great international gathering of engineers in Chicago next September, with a convocation of unprecedented magnitude and importance and with its pageant and exhibits at the Museum of Science and Industry, overshadows all other Society objectives and will constitute the core of my year's prime interest. These Centennial celebrations will be of significant influence, not alone on the engineer, but on all society. In a clear, simple way, we will depict to all that America's prosperity and high living standards have resulted from the engineer's working partnership with management, finance and skilled workmen.

So the keynote and what I hope will be the motivating theme of this year, in the organized activities of every branch and with every gathering of engineers, is not alone the substance of the celebrations marking 100 years of engineered progress, but of equal or greater importance, the inherent implications and obligations. For if we permit our justifiable pride in our accomplishments to blind us to the deeper significance of the meaning of our Centennial, then we will be unworthy of our heritage and of the genius of those who have made our profession great. Because this Centennial will depict much more than a record of grand accomplishments—with its compelling story of the prosperity that is now enjoyed as the fruits of our efforts—there will be interwoven the clear lesson that the success of past efforts would have been impossible, and that the hope of continued progress and creative accomplishment will be unattainable, if the operation of a competitive economy is choked off by the imposition of paternalistic state controls, and restrictions on private enterprise.

Engineers Have Played Decisive Roles

In this year of the full maturity of engineering, we look back on 100 years during which our profession has played its full part in the development of our country; we have held decisive roles in every war; we have been pioneer, leader and inventor in all fields of production and national development for the improved living standards and greater comfort of our fellow men; and, particularly in recent years, we have accepted responsibilities and leadership in the solution of non-technical problems in the public welfare.

When the help of the engineer was sorely needed in our hasty rearmament in preparation for participation in World War II, the Engineers National Defense Board was created, whereby each of the constituent societies of EJC drafted its selected members for service in preparing study reports, codes and research conclusions that proved invaluable to our war effort and to the balance maintained in civilian production.

When the now fortunately forgotton Morgenthau Plan for the reduction of all of Germany to a strictly agrarian state was publicly announced, Engineers Joint Council challenged our State Department and demanded the opportunity to prepare an intelligent program for the industrial demobilization of aggressor states. As a result, the studies and reports of the National Engineers Committee of EJC on the industrial demobilization of Germany and Japan were employed by the Allies for a far more rational solution to a problem that would otherwise have come home to damn us in our present strained relationship with Russia. These reports could only have been prepared by men of broad technological knowledge and experience, whose training in thorough analytical thinking inhibited their capacity to compromise with internal or local political considerations of the moment. Wide public acceptance of these works, both here and abroad, demonstrated the public's confidence in applied engineering judgment.

Civilization is now faced with another false politico-economic ideology, far more insidious and destructive than a Morgenthau Plan or any other that has so far challenged our progress. Of course I refer to that philosophy which today appears to permeate much political thinking throughout all Europe and the Western Hemisphere. This is the philosophy of "something for nothing"; that only a sucker works any harder than he has to; that the modern machine with its straight-line production has eliminated the need for industrious work; that ideas are now a natural resource; that profit to the investor and reward to experience gained through hard work and application, to management, and to creative effort are little short of immoral and can be taxed out of existence without destroying our economy. Far too many of us accept the false thesis that moral lassitude in public office, public subsidy of indigence and tax-supported boondoggling; the trading of the dignity and integrity of the individual for a super-state and the sacrifice of our priceless national heritage of morality, the dignity of work, and the essential place of God in our daily life are but a fair price to pay for the new, abundant, indolent, life.

Statism, in its insidious usurpation of the rights, liberties and incentives of the individual, may in its end result be more permanently destructive to human rights than Communism, for the more subtle reason that statism is being approached through the democratic process, whereas Communism has only been enforced on any people through a police state supporting a ruthless dictatorship.

Dr. Lin Yutang has this to say:

> Modern civilization would be destroyed if the things that make civilization, freedom of belief, the rights and liberties of the individual, and that now tottering faith in the common man—if these things were destroyed. Without war, a totalitarian state which deprives men of these gifts of civilization and sets men as spies upon their fellow men has already begun to destroy civilization. With a nation not so easily regimented, where the spirit of man remains free, that civilization cannot be destroyed by a war.
>
> There is every sign of the danger that in contemporary thinking and contemporary life, such common privileges of living are

economy and individual initiative

CARLTON S. PROCTOR, President of ASCE, Consulting Engineer, New York, N.Y.

increasingly giving way to the claims of the state-monster.

And so what threatens civilization is not war itself or the destruction of war, but the changing concept of life values entailed by certain types of political doctrines.

What is destroying civilization is the tendency to surrender the rights of the individual to the state:—such a powerful factor in contemporary thinking.

Even among the most intelligent it has become the style to blame all this on the government administration in office, on party politics and on almost everything except the real cause; lack of intelligent, honest leadership, that has created a confusion of the electorate in every democratic country and loss of confidence in established political institutions. Every honest, thinking man knows that every administration in office adheres reasonably closely to the attitude of the majority and we all know that government is simply us, every single citizen.

Of all groups in our economy, none in their daily work and in their essential attitude to the accomplishment of their jobs, so completely refute these politico-economic doctrines as does the engineer. Show me the professional man who works by the clock and the dollar sign, the man who has lost his high sense of values in moral principles, he who no longer believes in the dignity of hard work, in the rights of his fellow man, but accepts the principles of state control of ideas, denial of initiative, and confiscation of risk investment—show me that man and I will show you a charlatan and a menace to his community.

Add to the basic qualifications and experience of the engineer, the public confidence in which he is deservedly held, and you have my thesis—that immediate assumption of leadership in public thinking is not only the urgent responsibility of the engineer, but is his best hope of conserving the fruits of the labor of his profession and of modern civilization.

And there is another and equally important opportunity for leadership by the engineer. Some 22 years ago, the then second ranking Communist leader in Russia told me that their plans and program for world expansion were based primarily on the exploitation of the weaknesses and sore spots within every other nation, particularly the democracies, so as to set class against class and stir up labor-management disputes so that they would reap the harvest of resulting chaos. Ever since, in those private conversations in Moscow, it was pointed out to me that ours was one of the most vulnerable societies to communistic encroachment, because our country harbored the greatest extremes in intolerance—religious, racial, and sectional—ever since that time, I have been trying to point out to engineers the power that they possess to oppose intolerance in all its forms.

Many engineers have enjoyed the sort of rich experience that I have, that of working closely and intimately with the peoples of many lands—not those of a single class such as management, labor, industry, press or diplomacy—but the peoples of all classes; for the engineer must know and hold the confidence of all with whom he works, from the lowest peon to the governor, if his work is to succeed.

Of the many people of differing nationalities with whom I have worked, I have never known any that I did not like and admire. Some of my most loyal friends are men of widely different faith, race, and culture from my own.

Out of these experiences and friendships in foreign lands has grown my conviction that the unique experiences of the engineer—unique because of the full confidence and trust in which he must be held—place him in the most ideal position to expose to the light of public view, the most cancerous growth in our body politic—our intolerances.

The rich opportunity that confronts the engineer for leadership in guiding men's thinking back to the simple precepts of faith in their God, the dignity of work, and the essential brotherhood of man throughout the four corners of the earth, are poignantly illustrated in Nevil Shute's recent book, *Around the Bend*.

If I were a Paul Hoffman administering the magnificent Ford Foundation, I would distribute a copy of this book to every engineer in every land because this book offers the sort of basic philosophy men crave. It demonstrates the importance of the industrious life, the reliance that men must place on the engineer for their every-day safety and therefore the international character of engineering science, the unity of the aspirations and goals of men, and the fact that man's innate desire for brotherhood is thwarted only by evil leadership.

If our great engineering profession in all its branches can take from this book its clear injunction that theirs is the task of leadership out of the present international confusion of thinking, away from the soul-destroying philosophy of maximum return for minimum effort, then and only then will we have justified our pride in these past 100 years of engineered progress and have proven our right to this rich heritage of tradition and great works.

Civic Program in Every Local Section

For the ASCE membership this means a dedicated, civic leadership program in every Local Section. Such programs should include continuous activity and participation in all matters of public welfare, and particularly in subjects relating to the social influences, economic impact, and cultural implementation of the direct products of engineering effort. It requires interest in, and influence on school boards, public works commissions, local, state and national legislation, and above all, the exercise of political and economic guidance in public affairs.

For you as an individual engineer, it means an active interest in your Local Section and its possibilities for leadership in your community. It means your taking the lead when necessary in the development of those possibilities. It means your willingness to accept and to work on committee assignments, local and national. In short, it means that each one of us must use for public as well as for personal welfare, the engineering common sense which the practice of our profession instills in all of us.

The 400,000 engineers in our nation possess today a magnificent opportunity to make the profession's greatest contribution to the cause of civilization. I hope the American Society of Civil Engineers will accept its full share in making such a contribution during the coming year.

Cooperative project increases usefulness of Cooper Union's surveying camp

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DETERIORATION of the wooden footbridge at Cooper Union's surveying camp inspired the staff and students of the Civil Engineering Department to undertake the construction of a modern concrete dam and footbridge. The Green Engineering Camp at Ringwood, N. J., was in need of stream-gaging facilities for instructional purposes as well as a new footbridge over Ringwood Creek. The camp takes its name from Norvin H. Green, great grandson of Peter Cooper. Mr. Green donated the property in 1941.

The project started in the summer of 1948, when it became evident that the old footbridge would have to be replaced. From this small beginning interest in the work spread until it encompassed not only the whole civil engineering department of faculty and students, but the Alumni Association as well. As the design progressed, the latter agreed to pay the entire cost of construction.

Dam Designed as Class Work

The civil engineering class of 1949 undertook the design of the dam and appurtenant structures as its senior-year project, combining classroom studies in hydrology, hydraulics, and structures.

First, the drainage area was determined by planimetering Geological Survey quadrangles and found to be 17.5 sq miles. A plan and profile of the area in the vicinity of the proposed site was drawn from field surveys made during the summer surveying session. Several possible sites were selected and, after consultation with the President of The Cooper Union, the exact site was chosen. A more detailed survey was then made by the students and plotted to a scale of 1 in. = 20 ft. Design of the dam itself could now be started to suit the topography. See plan and cross section, Fig. 1.

Studies of the runoff of the Ringwood River for a 12-year period, based on Geological Survey gaging records made at the mouth of the river, indicated that a flood of 1,000 cfs might be expected at the dam site about once every 100 years. Because of state laws regulating stream flow, it was decided to keep the height of the dam crest less than 5 ft above mean low water. It was also desired to protect the trees and play area along the river from flood waters. After several trial schemes were drawn up, a spillway width of 42 ft was chosen since it would pass 1,000 cfs with a head of 4 ft over the crest of the dam. It may be of interest to state that the 100-year flood actually occurred about two months after the dam was completed. The water came within 2 in. of the under side of the bridge floor without causing any damage to the structure.

Soil studies were made by taking samples from test pits. On the basis of the soil conditions found, and with economy as the keynote, a concrete gravity-type spillway was chosen, with crest $4^1/_2$ ft higher than the improved stream bed and placed on a substantial mass-concrete footing. In the center of the spillway a notch 4 in. deep and 10 ft long was placed to provide a check on the accuracy of stage discharge measurements that might be made by students during periods of low discharge. The spillway section is flanked by earth levees designed to hold the water 4 ft above the spillway crest with a freeboard of 1 ft.

Since the soil studies showed that the earth in the $^3/_4$-acre area upstream from the bridge was highly permeable, it was decided to build a 12-in. concrete core wall in the earth levees, and to carry it down to a hardpan layer 5 ft below the stream bed.

Footbridge Over Spillway Crest

The spillway is spanned by two I-beam stringers which support the footbridge above the crest without intermediate supports. The footbridge is 5 ft wide between timber curbs and is designed for a live load consisting of two lines of people at 150 lb per ft of line. The 14WF30 steel stringers are 45 ft long. They are anchored to the bridge seat by a pair of $^3/_4$-in. round bolts at each end. At intervals of 8 ft 9 in., 12-in. I-beam diaphragms connect the two stringers to brace them against lateral buckling of the compression flange. On the top of the stringers, 8 × 6-in. timbers were fastened rigidly to the steel stringers by galvanized machine bolts. The 2 × 10 deck planking, spiked to the wooden timbers, formed the walkway. This arrangement will simplify replacement of the deck. A wooden handrail on each side completed the bridge.

The retaining walls flanking the bridge seats, like the spillway and its mass-concrete footing, were designed of plain concrete of gravity section to eliminate all need for reinforcing steel. The wing walls and bridge seats are 32 ft long, with the top of the back wall level with the footbridge floor.

The area upstream from the spillway was enlarged by digging and grading to create a scenic pond about three-fourths of an acre in extent. To provide means for draining this pond, an 18-in. steel pipe was run through the levee on the west side of the spillway, with a gate valve in a manhole located on the center line of the levee. On the east side of the spillway, a concrete fish flume 2 ft wide by 6 in. deep was provided to

meet the requirements of the fish and game laws.

On the east bank, to the north of the bridge, a 4-ft square concrete well was constructed for a water-stage recorder. This recorder was installed in September 1951. It is planned to keep records of water stages and to correlate them with stream discharges as measured by current meter. The computed measurements will be correlated with rainfall records and the information will be used in classes in water supply and hydrology.

Sequence of Construction Operations

Construction started with the digging, by bulldozer, of a diversion channel through the naturally low area to the west of the dam site. Earth for the foundation of the spillway was next excavated and the concrete for the spillway footing was poured, without forms because of the presence of hardpan. The core wall behind the east abutment was poured integrally with the abutment. The core wall on the west side was poured in 20-ft alternate sections.

Equipment for the job consisted of a bulldozer and a crawler crane with a small clamshell bucket. The concrete was supplied by transit trucks from a nearby town. The contract for the construction was let to McGurdy Construction Co. in August 1950, and construction was promptly started with a force consisting of a foreman, two skilled mechanics and two to five laborers. The project was completed by the first of October 1950.

The contract price was $13,744.17. This low price was made possible because there was no charge for engineering, and local day labor was utilized to the full. Professor Eichler is in charge of the surveying instruction at the camp.

COMPLETED spillway is spanned by footbridge (above and right). For esthetic reasons the spillway height was chosen so as to save several fine trees. Recreational features are seen in view upstream from dam (top, left) showing impounded pond and one of camp buildings. This building contains drafting rooms, dining room, lounge, workshop, and offices.

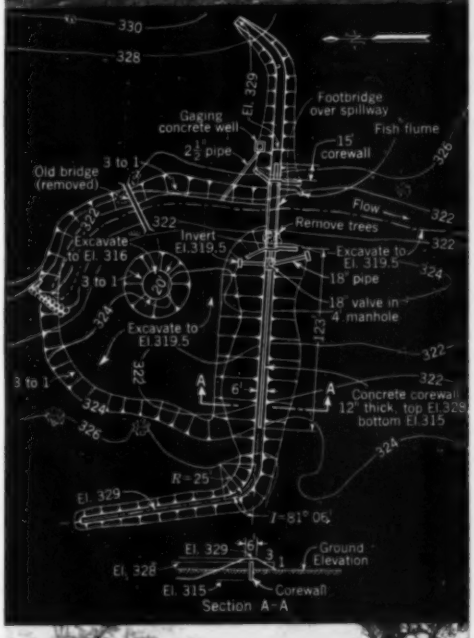

FIG. 1. DAM consists of two earth levees, with concrete core walls, connected by mass-concrete gravity spillway 42 ft long, with footbridge above. Area of about three-fourths acre upstream was excavated to form recreational pool, which can be drained through pipe of 18-in. diameter in west levee near spillway.

POURING was done from concrete bucket placed by crawler crane. View below shows completed wingwall with integral corewall at left and forms for wingwall in place at right. Spillway footing is partly poured.

Brazil's Paraiba-Pirai Diversion Project includes

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Respectively Vice-President and Construction Manager, Hydroelectric Construction Dept. of COBAST, Rio de Janeiro, Brazil, and

THE FIRST article on the Paraiba-Pirai Diversion Project, by the same writers, appeared in the October issue of CIVIL ENGINEERING. It covered the initial diversion of Paraiba River water by the Santa Cecilia Dam and pump station. The water, it will be recalled, is then lifted 33 ft, mostly by off-peak power, and flows through the Santa Cecilia Canal and Tunnel into the Santana Reservoir, which is formed by Santana Dam. The subsequent passage of the water from Santana Reservoir through the Vigario pump house, reservoir, canal and tunnel and on to the Fontes and Forcacava power stations is described in this the second and concluding article on the project.

WATER DIVERTED from the Paraiba River, having been lifted 33 ft into Santana Reservoir, as noted in the previous article, is pumped by the Vigario pump station into a second reservoir, this time gaining about 115 ft of head. This additional elevation permits the water to flow by gravity throughout the remainder of its trip to the power stations. The pumps at the Vigario station, like those at the Santa Cecilia station, are each rated at 1,410 cfs. Because of their much higher power requirements, they will be stopped during peak loads, and if necessary will be reversed to help in the generation of power to carry system peaks up to a maximum of 50,000 kw. Consequently five pumps, with a total capacity of 7,060 cfs, are being installed in the Vigario pump station: (1) to provide reserve capacity for catching up on the water which Santa Cecilia will have been pumping continuously; (2) to recover whatever flows have been let out of Vigario Reservoir for peak-load generation by the reversed pumps; and (3) to pump the additional Pirai River drainage coming in between the Tocos and Santana Dams.

The pumps at Vigario are similar to those at Santa Cecilia in mechanical and hydraulic features. They have vertical-shaft, single Francis-type impellers and operate at 166⅔ rpm, but because of the greater lift of 118 ft at Vigario, the runner has a large diameter, and each motor is rated at 22,500 hp. The discharge from each pump passes through a 11.5-ft-dia butterfly valve and an exposed steel penstock 230 ft long and 13.1 ft in diameter to a discharge structure which empties into the Vigario Reservoir.

The Vigario Reservoir is formed by two earth dams, the Vigario Dike, which closes a saddle about 99 ft high, and the Vigario Dam, about 131 ft high, which impounds Vigario Creek, a former tributary of the Pirai River.

Available Earth Fill Poor

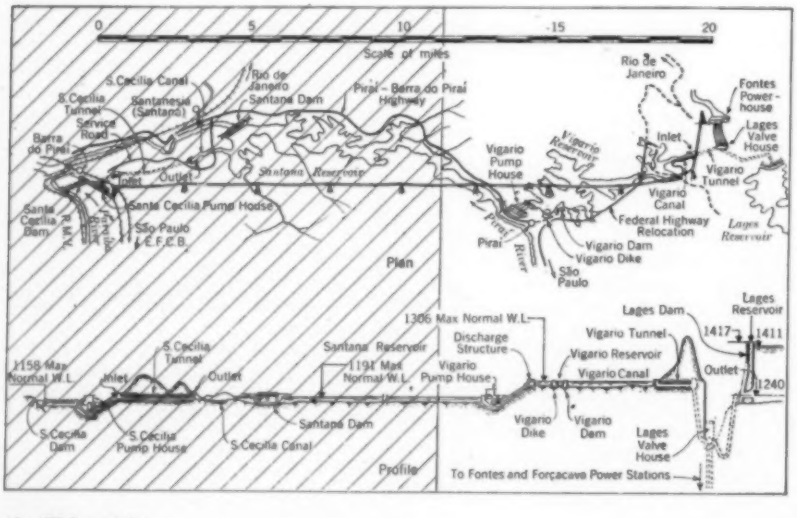
The earth formation at the two sites consists of decomposed gneiss. The lack of sufficient gradation in the soil prevented the construction of hydraulic-fill dams and made it necessary to resort to rolled-fill construction at both sites. The decomposed gneiss, when worked on, becomes a soft silt-clay mass. Under the Durean classification of 12 types of materials suitable for earth dams, with No. 12 as the least suitable, the Vigario material ranks in category No. 11. In fact, the Vigario material has a higher clay content than the well known "soft Chicago clay." In view of the importance of the Vigario Dam and Dike, Dr. Karl Terzaghi was retained to develop the designs and specifications for both.

Special precautions had to be taken, during construction and after, to prevent saturation of the fill so as to maintain satisfactory shearing resistance. Every few hours samples were taken from the borrow area to check the moisture content against the previously determined optimum. When the fill material was too wet, it was spread out and permitted to dry before rolling, and when it was too dry, it was sprinkled with water.

To protect the downstream part of the dam from excessive saturation after the reservoir is raised, a vertical sand filter was built to intercept any seepage through the upstream side. The seepage water flows down through this vertical filter until it reaches a horizontal rock filter at the base of the dam. From this filter the seepage flows through drain pipes to a permanent sump.

The valleys of both dam sites were originally filled with a black organic

FIG. 1. **ON GENERAL PLAN and profile of Paraiba-Pirai Diversion Project, part covered in this article is unshaded. Separate parts appear in following figures: Vigario Pump House, in Fig. 2; Vigario Dam, in Fig. 3; Vigario Canal and Tunnel Sections, in Fig. 4; and Lages Valve House, in Fig. 5.**



world's largest underground power station

GEORGE O. VOGAN, Manager, Engineering Projects Division, Canadian Brazilian Services, Ltd., Toronto, Canada

muck which offered practically no resistance to sliding. This muck had to be stripped down to a foundation of clean, weathered rock. The underlying gneiss contains many fissures, and it was felt, at first, that a grout curtain would be required to prevent seepage under the dam. As a test, grout was pumped into a hole drilled in the foundation, and another hole was drilled only 1 meter away. No grout was encountered in the second hole during drilling. The second hole in turn required about as much grout per linear foot as the first hole—an indication that a grout curtain would be very expensive.

It was decided, instead, to intercept the underground seepage by vertical filter wells spaced $6^1/_2$ ft apart, and going down to sound bed rock at a depth of about 46 ft. These vertical filter wells were placed directly below the vertical sand filter in the dam and are thus directly connected to the horizontal filter and sump pit. A cutoff trench was also dug to further lengthen the seepage flow path and thereby reduce the seepage under the dam. Rate of seepage will be measured in suitable observation wells, and if it becomes excessive, grouting may be resorted to.

Vigario Dam and Vigario Dike contain respectively about 1,195,000 and 972,200 cu yd of rolled fill. Placement was almost exclusively by tractor-drawn scrapers, except for the downstream section of Vigario Dam, where the fill material was delivered by dump trucks and spread by a bulldozer. The fill was placed in layers about 6 in. thick and compacted by extra-heavy sheepsfoot rollers. Eight passes of the roller were required before an additional layer of fill could be placed. Near the vertical filter and adjoining slopes, where the rollers could not pass, compaction was carried out by mechanical tampers.

Special precautions were taken during construction to keep the surface of the fill at optimum moisture levels by utilizing the permanent drainage system, by installing special construction drains and sumps which were constantly being pumped out, and by stripping the saturated surface materials after rains before new fill was placed.

Water from Vigario Reservoir flows by gravity through the Vigario Canal and Tunnel to the Forçacava valve chamber. The canal is 4,500 ft long, 46 ft wide at the bottom, and has 3:2 side slopes. It was excavated chiefly in earth and is concrete lined. Water enters through a reinforced concrete intake structure equipped with sec-

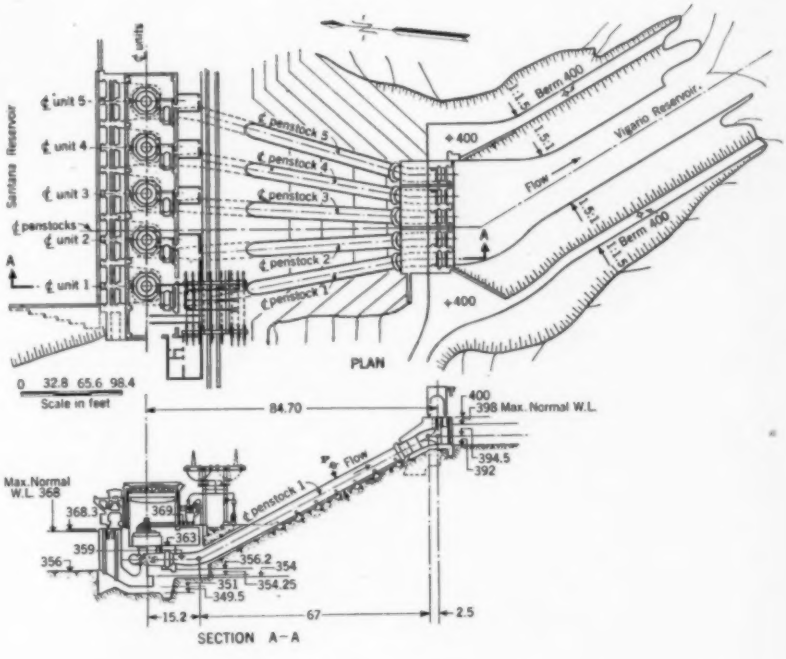
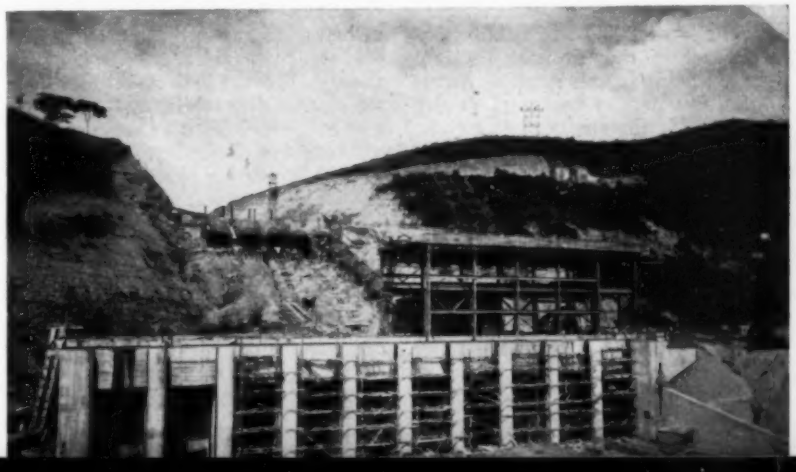


FIG. 2. VIGARIO PUMP HOUSE includes five vertical-shaft, single, Francis-type impellers operating at $166^2/_3$ rpm, each rated at 1,410 cfs. Because of greater lift than at Santa Cecilia Pump House (118 ft as compared to 33 ft), runner has large diameter and each motor is rated at 22,500 hp. At peak loads pumps can be reversed to help in generation of power. Photo (below) shows pump house under construction.



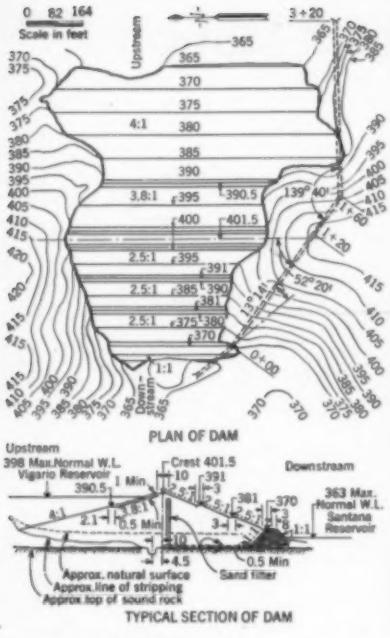


FIG. 3. VIGARIO DAM, about 131 ft high, contains 1,195,000 cu yd of rolled fill. Design of 99-ft-high Vigario Dike is similar.

VIGARIO DIKE contains about 972,200 cu yd of rolled fill, placed, like Vigario Dam, almost exclusively by tractor-drawn scrapers. Nature of soil at both sites a decomposed gneiss, prevented use of hydraulic fill. View is from downstream.

tional racks and two intake gates mounted on wheels. A self-slewing stiff-leg derrick will be mounted on the intake deck to manipulate the gates and clean the racks. The tunnel is 1,970 ft long, with a cross-sectional area of 615 sq ft. At its downstream end the flow divides into three branches at a distribution manifold. The discharge capacity of this tunnel is 11,300 cfs, or double the general diversion capacity, to permit utilization of the water as required by the system load factor.

Design of Valve Chamber

The valve chamber (Fig. 5) is designed to meet a variety of conditions of water supply and utilization. Valves are of the butterfly type, 17 ft in diameter, designed for a maximum surge head of 283 ft. Initially five valves out of the ultimate total of eight are being installed. The valves will be operated by high-pressure oil pistons and cylinders.

During flood seasons, the intakes to the Lages Tunnel at the Lages Reservoir will be closed, and the run-off into the reservoir will be stored. Diverted Paraiba-Pirai water will flow through the valve chamber directly to the Fontes and Forçacava power stations. During the dry season, when the Paraiba-Pirai flows will be low, there will be only enough water from this source for one of the Forçacava power stations. The Fontes station and the other Forçacava station will have to operate on stored water from Lages Reservoir, and the valves in the valve chamber will be manipulated accordingly.

During intermediate seasons, the Fontes power station will be supplied by Lages water. One Forçacava station will operate part of the time on water from Vigario Reservoir and part of the time on that from Lages Reservoir, requiring switching of the flow in the valve chamber. This switching of valves will be accomplished when the total system load can be carried with one plant shut down for several hours. Although the butterfly valves are designed to permit operation under full discharge velocities, they will normally be operated when no flow is passing through them, which merely requires selecting a time of the day when system conditions favor a shutdown.

There are no immediate prospects that the pumping of surplus Paraiba-Pirai diversion water into the Lages Reservoir will be justified, but the valve chamber has been excavated to a sufficient size and fitted with the necessary intake and discharge passages to permit the installation of a pump at some future date if desired.

The original plan of power development contemplated the utilization of the Paraiba-Pirai diversion waters by installing the new generating units in an addition to the present Fontes Powerhouse. This plan posed some extremely difficult problems connected with the construction of a large valve house near the top of the hillside and designed to distribute water from two different sources into each of 12 new penstocks. Equally difficult were the problems involved in locating the large number of new penstocks and their anchor blocks on the insecure slopes of the deeply weathered hillside. Furthermore, the valley here is so narrow at the bottom that there was no space for an addition to the existing Fontes station. Therefore, if this plan had been followed, it would eventually have become necessary to make room for some of the new generating units by removing the eight old units installed in 1908–1913.

After a careful study, made in 1948, of Swiss and Swedish engineering practices in the construction of underground power stations, it became evident that these European developments offered the best solution for the conditions encountered at Fontes. Extensive diamond drilling of the rock formation and geological investigations by Portland P.

Fox, Assoc. M. ASCE, geologist, established the suitability of the site for an underground development. After a consideration of various schemes, it was decided to build an underground valve chamber and pressure shafts to initially one, and later two, underground stations, to be known as Forçacava Nos. 1 and 2.

Forcacava Power Plants

The underground installations will be more economical than an outdoor extension of the Fontes plant for three main reasons. First, the productive capacity of 44,000 kw of the old Fontes units can be permanently retained, initially to meet the current shortage of system capacity, and later, when more efficient units are available, to serve as standby capacity during emergencies. Second, the single underground penstock shaft will be considerably cheaper than an equivalent surface installation of six steel penstocks with expensive anchorages and supports. The welded steel lining in the penstock shaft is chiefly designed to provide watertightness, and will carry only 30 percent of the total water pressure, while the surrounding rock will carry 70 percent of the pressure, except at the distribution manifold at the power cavern, where the steel is designed to carry the full pressure. Third, maintenance costs will be considerably reduced and the danger from earth or rock slides will be eliminated.

Because of space limitations, the Forçacava underground power stations cannot be fully described here. When completed, Forçacava No. 1, with its capacity of 330,000 kw, will be one of the largest underground plants in the world. Forçacava No. 2, now in the design stage, will have a capacity of 390,000 kw. The six units for Forçacava No. 1, consisting of two of 35,000 kw and four of 65,000 kw, are in various stages of manufacture. The first 35,000-kw unit is scheduled to go into operation in December 1952, and the remaining units will follow as rapidly as they can be installed. The turbines are of the Francis type, designed for a head of 1,130 ft, and there is a spherical-type, double-seated inlet valve at each turbine.

The rapid construction of a hydroelectric project as complex as the Paraiba-Pirai diversion had not previously been attempted in Brazil. In 1946, when work was begun, experienced construction services and the great investment in plant and equipment for such work were not obtainable locally. The construction organization of the Rio de Janeiro Tramway, Light and Power Co., known locally as the "Light," which had successfully completed similar important structures in previous years, but at a more moderate tempo, had become depleted when some of its most capable men were diverted to the war effort or into other industries. Furthermore, the organization had to be enlarged and equipped with new plant for several other projects which were scheduled for construction during this same period.

It was therefore decided to enter into an agreement with Morrison-Knudsen do Brasil, which had established itself in Brazil during the war years and could draw on the resources of experienced management, supervisory personnel and construction equipment of its parent company

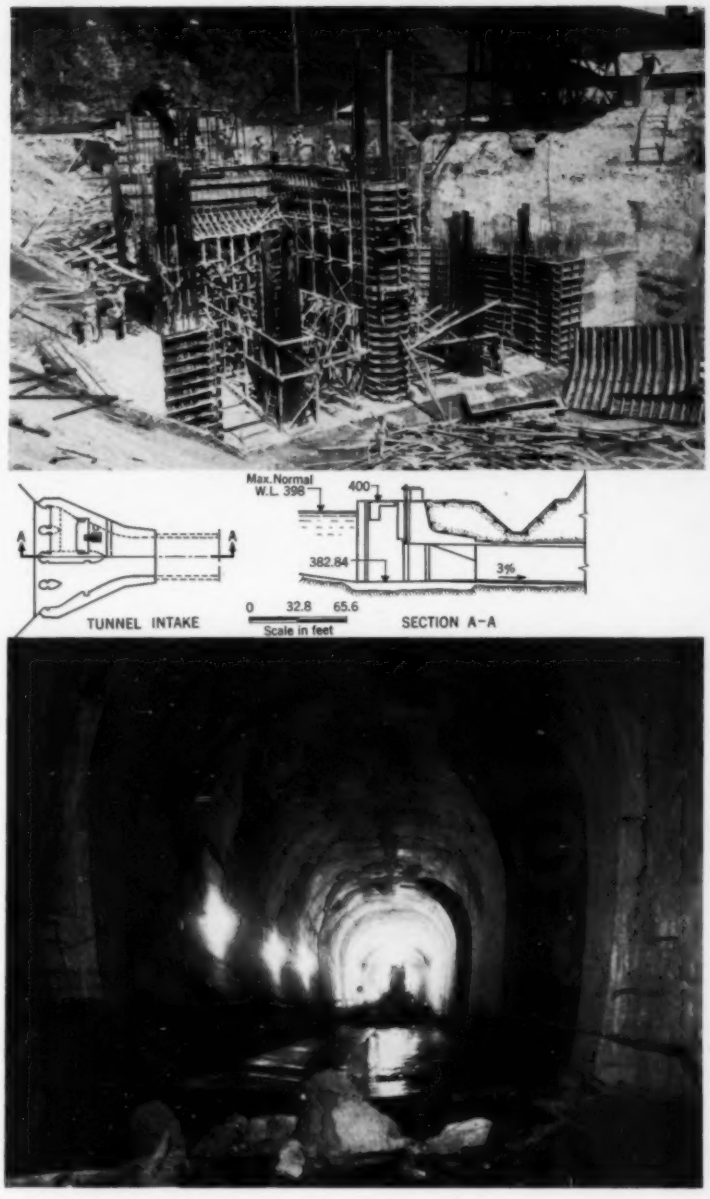


FIG. 4. VIGARIO CANAL (4,500 ft long) and Tunnel (1,970 ft long) carry gravity flow from Vigario Reservoir to Lages Valve House. Tunnel intake is seen under construction in photo at top and lower end of tunnel, in lower photo. Openings which appear in tunnel at right are manifold entrances to valve chamber.

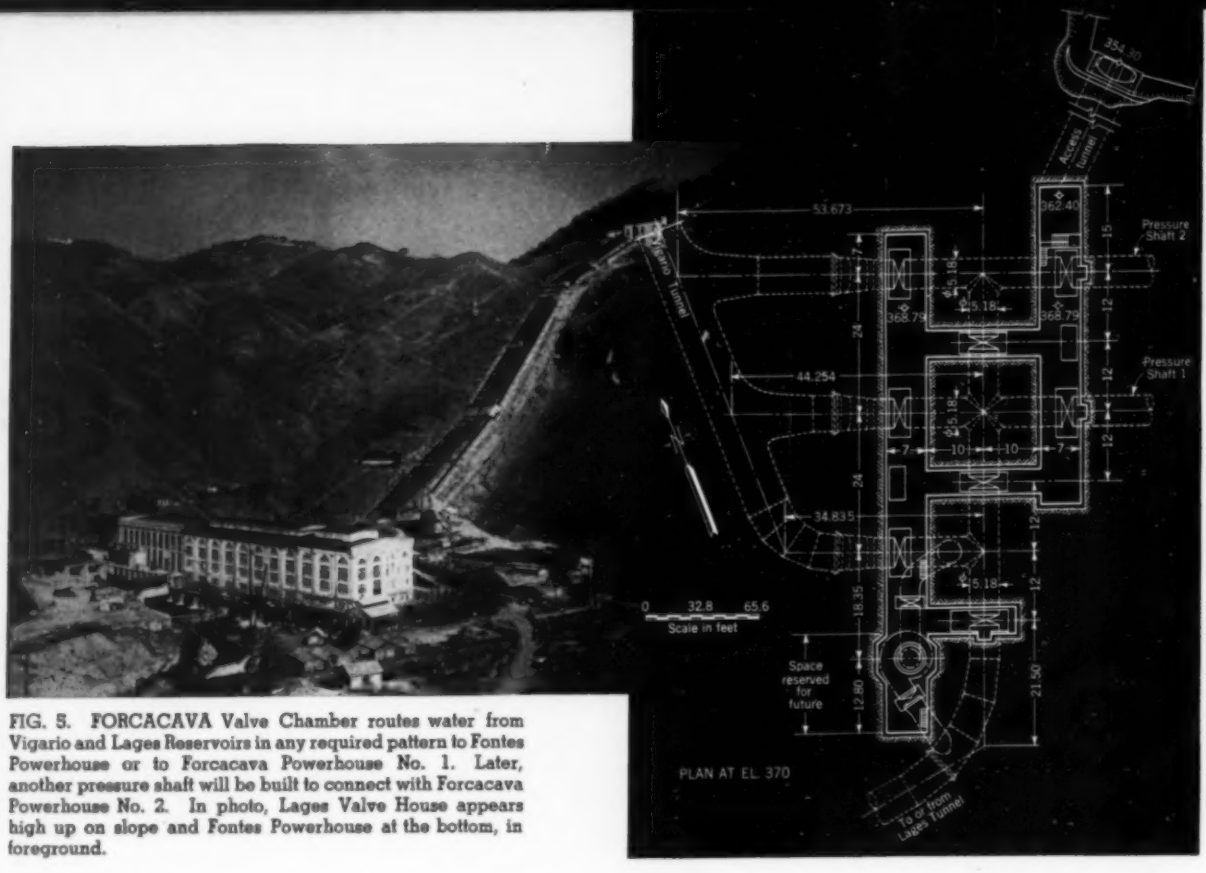


FIG. 5. FORCACAVA Valve Chamber routes water from Vigario and Lages Reservoirs in any required pattern to Fontes Powerhouse or to Forcacava Powerhouse No. 1. Later, another pressure shaft will be built to connect with Forcacava Powerhouse No. 2. In photo, Lages Valve House appears high up on slope and Fontes Powerhouse at the bottom, in foreground.

in North America. On the diversion project the total number of Brazilians averages about 2,000, and the skilled supervisory construction staff brought from North America averages about 70.

"Agency" Form of Agreement Adopted

It was not feasible or practical to enter into a unit-price or lump-sum contract because designs were not ready on which to prepare bids, and because there were many unforeseeable factors including changes in labor and material costs during the construction period. To get the work started as soon as possible, a special cost-plus-fee, or "agency" form of agreement was adopted. This permitted the constructor to start immediately on the mobilization of organization and equipment, and the construction of access roads, shop facilities, and housing. In the meantime general designs of each feature of the project were prepared by the engineers of the Light Company from which the constructor could determine the quantities in the various items of work, and thereafter prepare estimates of cost, called "target estimates." These included detailed descriptions of requirements with respect to supervisory staff, labor, materials, supplies, equipment, and construction methods, in practically the same detail as would be developed for a lump-sum bid.

At each step in the preparation of these estimates, the details were reviewed and agreed upon between the officials of the constructors and of the Light Company, so that a complete meeting of minds was established at the outset concerning the program of building the entire project.

Several conditions are essential if work is to be carried out successfully under this form of agreement, particularly in a foreign country. The constructor must supply skillful and experienced managers and supervisors who can readily adapt themselves to local customs, associations and language, and who have the interest and ability to train local labor. He must also provide competent direction and select first-class tools and equipment suited to the needs of the job. The client must accept a partnership relationship with the constructor, since the objectives of both parties are identical, and his supervisory staff must therefore be equally competent. The client must also recognize the need for making adequate investments right at the start, in the required construction plant and equipment, and in the construction of suitable housing and recreational facilities which contribute to good morale throughout the organization. This insures a minimum of turnover of personnel, especially among the supervisory staff and their families, who are expected to be away from their home country for three or more years. Finally, the client must delegate to the constructor adequate authority, commensurate with the responsibilities he assumes. The system of advance preparation of target estimates which are accepted by both parties, provides a basis of mutual understanding and confidence under which the constructor can be given a free hand to exercise his skill and administrative ability in carrying out the work in the most efficient and economical manner.

This project is being financed through a loan obtained from the International Bank for Reconstruction and Development.

Special acknowledgment is made to the engineers and supervisory staff of the Associated Companies of Brazilian Traction, Light and Power Company, Ltd., and of the constructors, for their important contributions to the Paraiba-Pirai Diversion Project in terms of technical skill and fine cooperative spirit.

Designing for nuclear shielding

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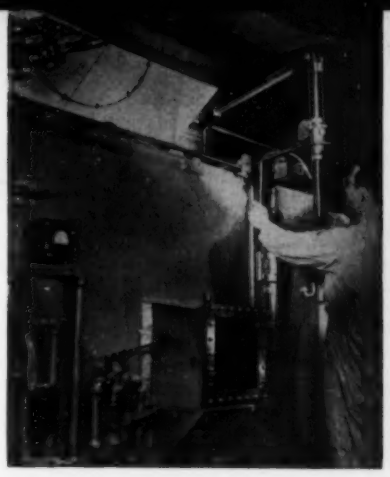
Engineering Department, Oak Ridge National Laboratory, Oak Ridge, Tenn.



OPERATOR, protected by lead barricade, looks into overhead mirror at radioisotope shipping bottle. Note liquid-filled window.

A SIMPLE EXPLANATION of how alpha and beta particles, neutrons, and especially gamma rays, react upon human tissue was given by Mr. Glen in the August issue, beginning on page 31. He also explained the nature of materials used for the construction of shields to protect personnel against injury from radioactive materials. In this second article, Mr. Glen gives basic design data for engineers faced with the construction of cells, barricades, and other forms of personnel shielding from radioisotopes. Both articles are based on the paper he presented at the Structural Division session presided over by Chairman Jewell Garrelts and held during the Annual Convention of the Society in New York.

PROBLEMS of personnel shielding against radioisotopes will be encountered by engineers with increasing frequency as these forms of atomic energy come into more general use, as they are sure to do. Radioisotopes have been called "the most useful research tool since the invention of the microscope." In 1948 the Atomic Energy Commission's Advisory Committee on Biology and Medicine stated that "the availability of radioisotopes is contributing more than any other factor today to the advancement of medicine and biology."

At this point many engineers will ask, "What is a radioisotope?" To answer this question it is necessary to review a few basic facts about the atom. The identity and chemical characteristics of an atom are determined by the number of protons in its nucleus. An atom having one proton in its nucleus is called hydrogen. There are 92 elements from hydrogen to uranium, and each successive element has one more proton in its nucleus than the one preceding. Thus, the last known element, uranium, has 92 protons.

Atomic nuclei contain neutrons as well as protons. However, the number of neutrons in the nucleus has no effect on the identity of the atom, although it does affect its weight. For example, the name hydrogen is given to all atoms having one proton in the nucleus regardless of the number of neutrons. Hydrogen with one proton and no neutrons in its nucleus has a mass number of 1 to indicate its atomic weight. If it has one neutron in addition to the proton, it has the mass number 2 and is called Hydrogen 2, or Deuterium. Similarly, if it has two neutrons besides its proton, it is called Hydrogen 3, or Tritium. These different hydrogen atoms are called isotopes—from the Greek *iso*, "same," plus *tope*, "place"—to show that while they are atoms of the same element, their nuclei are different.

Thus an isotope is one of two or more kinds of atoms that are of the same element but have different weights. A particular isotope is identified by the name of the element followed by a numeral indicating its weight, as given in Col. 1 of Table I, which lists a few of the more commonly used radioisotopes. A radioisotope is any isotope that is radioactive. All elements have one or more isotopes that can be made radioactive. The full designation of the radioisotopes is given in Col. 2 of the table, where the initial subscript is the atomic number of the element—ranging from Hydrogen 1 to Uranium 92, as previously explained. The superscript that follows the element designation indicates the atomic weight, as has been illustrated in the case of Hydrogen.

In designing personnel shielding from radioisotopes it is generally necessary only to take into account the gamma radiation in mev (millions of electron volts), as given in Col. 5 of Table I. In some cases, artificially produced radioisotopes as well as those occurring naturally also emit beta particles (Col. 4). For these it is evident that sufficient shielding to satisfy the gamma radiation is more than ample to stop the beta particles. In those cases where beta particles alone are emitted, a non-metallic shield such as Lucite would be used for storage and shipment. Thus it is seen that the engineer's design problems are concerned only with gamma radiation. In this article only lead is considered as the shielding material.

Problems of gamma radiation are divided into three steps, as follows:

Step 1 is the determination of the intensity of radiation, I_o, in roentgens (r) per hour, at the outside face of the proposed shield, using the equation,

$$I_o = \frac{6\,CE}{a^2} \text{ r per hour} \quad . \quad . (1)$$

in which

C = number of curies in source, measured in millions of electron volts, or mev. The value of C is always specified when a radioisotope is procured from Oak Ridge National Laboratory

E = energy in mev of photons (gamma energy) in source material (from Col. 5 of Table I)

a = distance from source to *outside* face of shield, in ft

Step 2 is the determination of the thickness of the shield by the exponential absorption law. This law is

$$T = k \log_{10} \frac{I_o}{I} \quad . \quad . \quad . \quad . (2)$$

in which

T = thickness of shield, in inches

k = number of inches of shield thickness required to reduce initial intensity, I_o, by a factor of 10. The value of k for lead is obtained from the curve, Fig. 1. Other materials have characteristic curves. That for concrete is shown in Fig. 2

I = desired final level of gamma radiation intensity after passing through shield. Safe tolerance is here considered to be 7.5 mr per hour

Step 3 is the addition of a "build-up factor" which must be added to

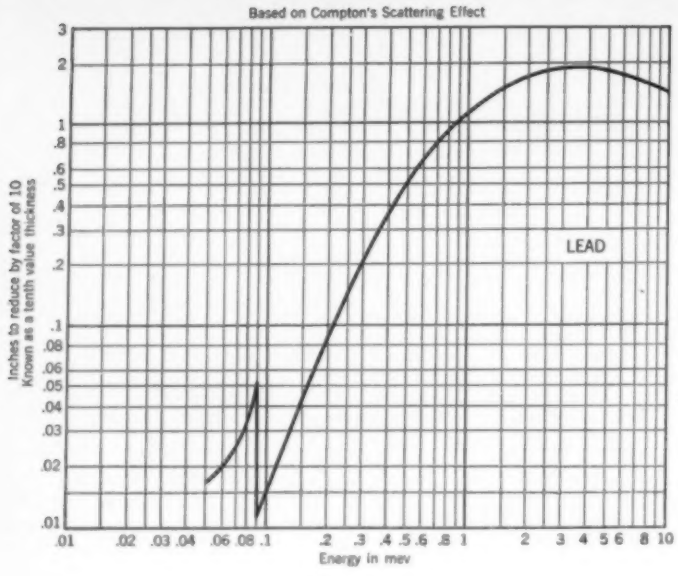


FIG. 1. THICKNESS OF LEAD, in inches, required to reduce gamma radiation intensity by factor of 10, as determined by entering curve at energy in mev and reading thickness on scale at left. Result is value of k for substitution in Eq. 2, Step 2.

compensate for deviations from the exponential absorption law. These deviations, which are due to Compton's scattering effect, are very difficult to compute. The factors that govern them are: (1) the thickness of the shield, (2) the energy of the gammas, and (3) the atomic number of the absorber.

It is necessary at present to use the exponential theory as a first approximation and to estimate the magnitude of the deviation as well as possible on the basis of experience. In general, for thick shields, that is, those with a 4-in. thickness of lead or a 20-in. thickness of regular concrete, and up, 25 percent is added to the theoretical thickness to compensate for Compton's scattering effect plus the reflection of the gammas from wall to wall.

For thinner shields, experience teaches that a lower percentage is required to be added to the theoretical thickness. A good estimate would be to vary the percentages of additional shielding from 25 percent at a 4-in. thickness of lead down to 0 percent for a 0.5-in. thickness.

To illustrate the determination of the needed thickness for shielding, three problems will be given and solved, using lead for gamma shielding.

Problem 1. Shielding the Gamma Emitter Cobalt 60 of 100-Curie Intensity

Given a point source of Cobalt 60 ($_{27}Co^{60}$) of 100-curie intensity. To find the necessary personnel shield thickness at 10 ft from the source to the outside face of the shield.

From the table of radioisotopes (Table I, Col. 5), it is found that Cobalt 60 emits two gamma rays of 1.17-mev and 1.33-mev energies respectively. A beta particle of 0.31-mev energy is also emitted, but for the sake of the shielding calculation, can be disregarded. The three steps previously outlined are followed.

Step 1 is to determine the radiation intensity, I_o, at the proposed location of the shield. The values to be substituted in Eq. 1 are

C = 100 curies (given)
E = 1.17 mev + 1.33 mev = 2.50 mev (from Col. 5 of Table I)
a = 10 ft to outside face of shield (given)

Substituting,

$$I_0 = \frac{6 \times 100 \times 2.50}{10^2} = 15 \text{ r per hour}$$

Step 2 is to determine the thickness of the shielding material by the exponential absorption law, Eq. 2. The following values are to be substituted:

k = 1.28 in. for the 1.17-mev gamma, and 1.40 in. for the 1.33-mev gamma (from Fig. 1)
I_o = 15.00 r per hour (from Step 1) = 15,000 mr per hour
I = 7.5 mr per hour (given)

Substituting the above values in Eq. 2 for the gamma ray of 1.17-mev energy,

$$T = 1.28 \times \log_{10} \frac{15{,}000}{7.5} = 4.23 \text{ in. of lead}$$

Substituting in the same way for the gamma ray of 1.33-mev energy,

$$T = 1.40 \times \log_{10} \frac{15{,}000}{7.5} = 4.62 \text{ in. of lead}$$

The first theoretical shield thickness found, 4.23 in. of lead, is based on the assumption that all the gamma rays are of 1.17-mev energy. Likewise the second theoretical thickness of 4.62 in. presupposes that all the gammas are of 1.33-mev energy. Neither of these assumptions is true, since Cobalt 60 emits gammas of both 1.17 and 1.33 mev. Therefore the true thickness of the shielding material required lies somewhere between the two values of 4.23 and 4.62 in. of lead. In practice, the larger

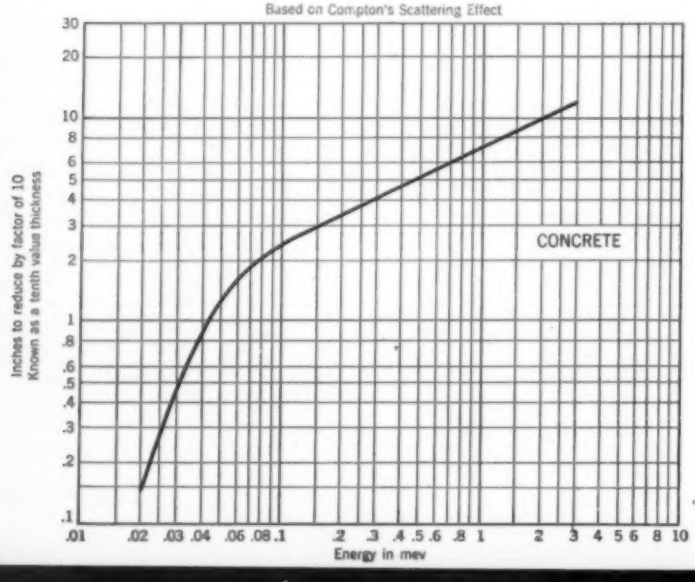

Based on Compton's Scattering Effect
CONCRETE
Inches to reduce by factor of 10
Known as a tenth value thickness
Energy in mev

FIG. 2. CURVE GIVES thickness of concrete, in inches, required to reduce intensity of gamma radiation by factor of 10. To solve specific design problem, same three steps are followed as are given in detail in article for lead. This curve is based on concrete weighing 150 lb per cu ft.

value, for the 1.33-mev gamma, would be used.

Step 3 is the addition of the build-up factor to take care of Compton's scattering effect. The previously computed figure of 4.62 in. of lead assumes that all scattered gammas are absorbed by the shield. This will not be true in most cases, and so about 25 percent would normally be added to the thickness to compensate for these scattered gammas. Thus, a 5.77-in. thickness of lead is found to be necessary for the shield required in Problem 1. In practice, however, we would use the nearest quarter inch, or $5^3/_4$ in.

Problem 2. Shielding the Gamma Emitter Cobalt 60 of 10-Curie Intensity

Given a point source of Cobalt 60 ($_{27}Co^{60}$) of 10-curie intensity. To find the necessary personnel shield thickness at 10 ft from the source to the outside face of the shield.

Step 1, as previously explained, is to determine the value of I_o by substitution of the proper values in Eq. 1. These values, for this problem, are

S = 10 curies (given)
E = 1.17 mev + 1.33 mev = 2.50 mev (from Col. 5, Table I)
a = 10 ft to outside face of shield (given)

Substituting,

$$I_o = \frac{6 \times 10 \times 2.50}{10^2} = 1.5 \text{ r per hour}$$

Step 2, previously explained, calls for substitution in Eq. 2. The values will be the same as in Problem 1, except for I_o, which in this case is 1.5 r, that is, 1,500 mr per hour. Thus for the gamma ray of 1.17-mev energy,

$$T = 1.28 \times \log_{10} \frac{1,500}{7.5} = 2.95 \text{ in. of lead}$$

Similarly, for the gamma ray of 1.33 mev energy,

$$T = 1.40 \times \log_{10} \frac{1,500}{7.5} = 3.22 \text{ in. of lead}$$

This larger value of 3.22 is to be used, as explained for Problem 1. In spite of the fact that the source in Problem 2 is only one-tenth as strong as that in Problem 1, the shield thickness has not changed very much. Decreasing the source by a factor of 10 means simply a saving of a tenth value thickness of the lead shield.

Step 3, the addition of the make-up factor, adds 20 per cent to the 3.22 in., making the total thickness 3.86 in. of lead. In practice we probably would use 4.0 in.

Notes to Accompany Table I

Some radioisotopes possess split personalities. These twins (or triplets, etc.) have different half lives and therefore different radiation emissions.

Beta and gamma radiations given in Cols. 4 and 5 have been interpreted from the decay patterns of the various radioisotopes, using information contained in *Nuclear Data*, National Bureau of Standards Circular 499.

The curie unit is a measure only of the disintegrations per second occurring in a radioisotope. In many cases one disintegration can lead to the emission of more than one gamma. Also, in some cases there is more than one possible method of decay. To accurately determine the total amount of radiation from a radioisotope, it is necessary to know its complete decay scheme. For engineering purposes, however, a simplified procedure can be used. The following is on the safe side and is suggested. The steps referred to are those used in the solution of the problems in the article.

Calculation of Radiation Intensity—Step 1

For those radioisotopes emitting a single gamma, of course this energy value is used for E (from Col. 5 of Table I).

For those radioisotopes emitting multiple gammas (cascade emission), the sum of the gamma energies given in Table I should be used for design.

For those radioisotopes having complex decay patterns, the approximate percentages of their gamma energies are shown in Table I as 1.20 (20 percent).

For design purposes the following example will suffice. Cesium 134 emits gammas of 0.568 (26 percent), 0.602, 1.35, and 0.794 mev respectively. The sum of these, or 2.89, mev should be used in design.

Calculation of Shielding—Step 2

For those radioisotopes emitting a single gamma, this value is used to find k in Fig. 1, the thickness of the lead shield required to reduce the radiation intensity by a factor of 10, known as a tenth value thickness.

For those radioisotopes emitting multiple gammas as well as those having complex decay patterns, computations should be based on the largest gamma energy, even though the percentage may be small.

TABLE I. CHARACTERISTICS OF RADIOISOTOPES PRODUCED AT ORNL

(Col. 1) Radioisotope	(Col. 2) Atomic No. & Weight	(Col. 3) Half Life	(Col. 4) Beta in mev	(Col. 5) Gamma in mev
Barium 131	$_{56}Ba^{131}$	12 days	None	0.26, 0.5, 1.7 (10%)
Cesium 134	$_{55}Cs^{134}$	2.3 years	0.658 (75%) 0.09 (25%)	0.568 (26%) 0.60, 1.35, 0.794
Cobalt 60	$_{27}Co^{60}$	5.3 years	0.31	1.17, 1.33
Gold 198	$_{79}Au^{198}$	2.69 days	0.97	0.411
Iodine 131	$_{53}I^{131}$	8.0 days	0.32 (15%) 0.60 (85%)	0.08 (8%), 0.28 (8%) 0.36 (100%), 0.64 (20%)
Phosphorus 32	$_{15}P^{32}$	14.3 days	1.712	None
Potassium 42	$_{19}K^{42}$	12.4 hours	3.6 (75%) 2.0 (25%)	1.51
Sodium 24	$_{11}Na^{24}$	14.9 hours	1.39	2.76, 1.38

Problem 3. Shielding the Gamma Emitter Sodium 24

Provide a personnel shield at 4 ft from a point source of 350 mc of Sodium 24. Sodium 24 ($_{11}Na^{24}$), as seen from Table I, emits two gammas of 1.38-mev and 2.76-mev energies, respectively. It is usually handled in intensities around 350 mc, or 0.35 curies.

Step 1, as in the two previous problems, is to find I_o by substituting in Eq. 1. The proper values in this case are

C = 0.35 curies (given)
E = 1.38 mev + 2.76 mev = 4.14 mev (from Col. 5, Table I)
a = 4 ft to outside face of shield (given)

Substituting,

$$I_o = \frac{6 \times 0.35 \times 4.14}{16} = 0.543 \text{ r per hour}$$

Step 2 requires substitution in Eq. 2 of the following values:

k = 1.85 in. of lead for 2.76-mev energy (from Fig. 1)
I_o = 0.543 r per hour (from Step 1)
I = 7.5 mr per hour

Then the shield thickness for 2.76-mev energy photon is

$$T = 1.85 \times \log_{10} \frac{543}{7.5} = 3.44 \text{ in. of lead}$$

Step 3, compensation for Compton's scattering effect, gives 3.44 + 20 percent = 4.12. Use 4.25 in. of lead.

FIELD HINTS

Oceanographic instrument aids bridge engineers in pouring under-water concrete

WAYNE V. BURT, Research Associate in Oceanography, and
D. W. PRITCHARD, Director, Chesapeake Bay Institute of The Johns Hopkins University, Baltimore, Md.

BRIDGE ENGINEERS are sometimes faced with the problem of determining subsurface water temperatures in order to find out whether they are below 35 deg F, the generally accepted safe minimum for pouring concrete. This problem came up during the late fall for members of the engineering staff of the J. E. Greiner Co., who are in charge of pouring the concrete piers for the new $40,000,000 Chesapeake Bay Bridge. They knew that personnel aboard research vessels of the Chesapeake Bay Institute, which is located near the bridge site, were making repeated surveys of physical and chemical conditions in the bay and so asked the Institute for help on the problem.

Examination of temperature data that had been collected in the area at that time indicated that although the surface temperature was very near the critical 35 deg F, the subsurface water was substantially warmer. Thus pouring at the required depths was perfectly safe. Since it was not known when this advantageous condition might change, it was desirable for the engineers to have a readily available means of determining the vertical temperature distribution. For this reason, the Institute loaned the engineers a bathythermograph which, after several months of use, has proved invaluable for easily and accurately determining subsurface temperatures. The instrument consists of a combination sylphon bellows for registering depth from the increase in hydrostatic pressure and a temperature-sensitive element. These elements are arranged to operate a stylus in such a way that a graph of temperature against depth is traced on a smoked glass slide as the instrument is lowered through the water. When the instrument is brought back to the surface, the slide is taken out and inserted into a magnifying, reading device that allows the temperature to be read to the nearest tenth of a degree at any desired depth.

The instrument was used during the months of December 1950 and January 1951. It indicated that although the surface temperature at times was slightly below 35 deg F, that of subsurface waters, below a depth of about 20 ft, remained well above 35 deg F. Thus concrete could be poured continuously at subsurface depths. The variation at the surface was such that there were no very long periods when concrete could not be poured at all depths.

This seemingly anomalous condition, where water is found to be warmer on the bottom than at the surface, may be explained by the fact that the warmer subsurface waters contain a higher percentage of sea water and thus are heavier than the colder, fresher surface water. Sea water is a good deal heavier at a given temperature than fresh water because of the addition of dissolved salts. Thus, this condition is found to exist only in areas where fresh and salt water are mixing, that is, under estuarine conditions. It may or may not occur then, depending on a number of factors such as amount of fresh water runoff, extent of tidal mixing, and depth of mixing due to winds blowing over the surface.

Data taken January 11, 1950, near the bridge are shown in Fig. 1, where temperature, percentage of sea water, and density are plotted against depth. This distribution is typical for winter. The temperature rises $2^1/_2$ deg F between the surface and the bottom. At the same time the percentage of sea water has gone up from 25 percent at the surface to over 50 percent at the bottom. The density curve shows a strong increase in density with depth in the region of maximum temperature and salinity increase. This shows that the salinity increase more than compensated for the temperature increase.

Engineers working in fresh water find that as cooling of the surface water progresses in the fall of the year, instability causes vertical mixing. This mixing continues as the cooling progresses until the temperature of maximum density (39 deg F) is reached. The water will then be isothermal from the surface to the bottom. Subsequent cooling at the surface will decrease the density of

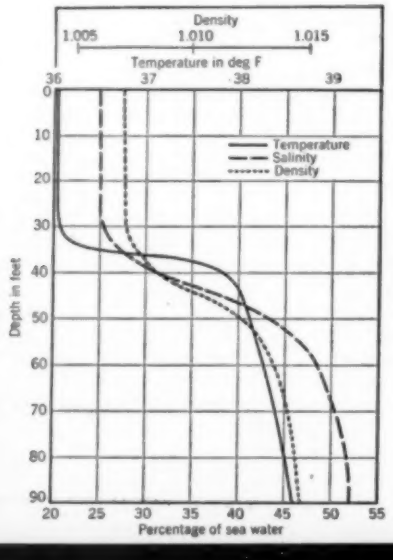


FIG. 1. GRAPH shows typical vertical distribution of temperature, salinity and density during the winter months in upper Chesapeake Bay.

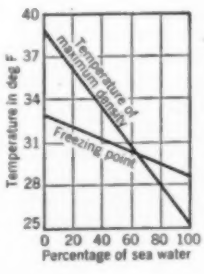


FIG. 2. DECREASE in temperature of maximum density and freezing point from 100 percent fresh water to 100 percent sea water is shown graphically.

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the surface water. The tendency to overturn due to vertical instability will cease. If no other process, such as strong winds or currents, is present to cause vertical mixing, the surface water may cool and freeze while the subsurface water remains at 39 deg F.

On the other hand, in full sea water the temperature of maximum density is below 26 deg F while the temperature at which ice begins to form has dropped to below 29 deg F. Thus, as cooling occurs at the surface, instability causes vertical mixing from the surface to the bottom until ice begins to form. The temperature at subsurface depths will continue to drop as long as the surface temperature drops. In the absence of strong winds or currents, subsequent warming at the surface will allow the surface temperature to rise while the subsurface water remains at the lowest temperature to which the surface temperature above it had fallen. This masked cold water remains until it is mechanically mixed or carried away. A graph of the temperature of maximum density and the freezing point, as they change in value from fresh to full sea water (100 percent) is given in Fig. 2. Note that the temperature of maximum density is below the temperature at which ice begins to form for all values above 65 percent of sea water.

From the foregoing it appears that, taking 35 deg F as the safe minimum pouring temperature for concrete, it might under some circumstances be safe to pour at subsurface depths in fresh water if the surface temperature were below 35 deg, but that it would never be safe to pour in full sea water if the surface temperature were below 35 deg.

In estuaries where surface waters may be a great deal fresher than subsurface waters, strong temperature inversions of as much as 10 deg F may occur during the winter months. These conditions make it imperative for engineers desiring to pour concrete during winter months in estuarine areas, where conditions may vary from full fresh to full salt water, to have some means of checking subsurface temperatures. The bathythermograph, although essentially designed as a scientific instrument, is rugged, sufficiently accurate, relatively inexpensive, easy to use, and ideally suited for this engineering use.

An early model of this instrument was described by A. F. Spilhaus (*Journal of Marine Research*, Vol. 1, No. 2, p. 95). It is at present manufactured by Wallace & Tiernan, Inc., Belleville 9, N.J., and The Engineering Laboratories, Inc., Tulsa, Okla.

ENGINEERS' NOTEBOOK

Formula presented for estimating flood discharges

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Brandão, Magalhães & Co., Ltd., Engineers and Contractors, Rio de Janeiro, Brazil

A FORMULA for estimating flood discharges is here presented which, because of its make-up and flexibility, should have a wide application.

Let

A = drainage area considered, in sq kilometers (total or partial watershed)

L = length of path of raindrop, in kilometers, from farthest point of area A to point where flood is to be computed

Q = maximum flood discharge, in cu m per sec

F = frequency factor. For a maximum storm, $F = 1.00$.

f = mean (weighted) average yearly rainfall in inches over area A

C = coefficient (see below)

K = coefficient, equal to, approximately, 1.00 for pastures or cultivated ground with some vegetation; 1.25 for barren or rocky slopes; 0.75 for highly wooded ground. Intermediate values may be used.

$$C = 1.28 - 0.07\,\frac{L^2}{A} \quad \ldots (1)$$

$$Q = \frac{17FCA\sqrt{f}}{\sqrt{A} + 10} \quad \ldots (2)$$

If greater accuracy is required, and the known data permit, the values obtained from Eq. 2 should be multiplied by the factor K.

It is believed that, during maximum storms, the percentage of runoff is approximately equal, regardless of the type of ground cover. However, thickly wooded ground, or ground covered with similar obstructions, retards the flow of rain. Therefore the concentration time is longer than in the case of barren ground. A longer period of concentration means, of course, a lower intensity of rainfall and a smaller runoff. This is what coefficient K tries to express.

As an example, use the following data:

A = 1,868,000 km²
L = 3,975 km
F = 1.00
K = 1.00
f = 37.20 in.

$$C = 1.28 - 0.07 \times \frac{3{,}975^2}{1{,}868{,}000} = 0.69$$

$$Q = \frac{17 \times 1.00 \times 0.69 \times 1{,}868{,}000\,\sqrt{37.20}}{\sqrt{1{,}868{,}010}}$$

= 97,800 cu m per sec = 3,450,000 cfs

These data refer to the Mississippi River, excluding the Missouri basin, this being, apparently, the combination producing the maximum runoff. The above results would appear to accord well with the estimates of maximum floods observed at the mouth of the Mississippi River.

Good results are also obtained for small areas by using Eq. 2, as can be seen from the following example. Take the data:

A = 58 km²
L = 18 km
f = 30 in.
F = 1.00
K = 1.25 (steep slopes and impervious surfaces)

$$C = 1.28 - 0.07 \times \frac{18^2}{58} = 0.89$$

$$Q = \frac{17 \times 0.89 \times 58 \times 1.25\,\sqrt{30}}{\sqrt{68}}$$

= 728 cu m per sec = 25,700 cfs

The above data are for the Dry Run River, Decorah, Iowa, where the estimated maximum flood is placed at about 26,000 cfs (*Engineering News-Record*, March 20, 1920, p. 565).

The variation of Q with $\sqrt{f}$ is a law discovered by the writer in 1930, and subsequently explained in various publications in Brazil, and also in private correspondence with an official U.S. Government department.

THE READERS WRITE

Helicoidal Staircase Built of Conventional Reinforced Concrete

TO THE EDITOR: Referring to the article, "Revolutionary Staircase Built of Prestressed Concrete," by Prof. G. Magnel in the September issue, it might be of interest to note that a somewhat similar staircase has recently been designed and built using conventional reinforced concrete construction.

This structure, the plan dimensions of which are shown in Fig. 1, is in the Administration Building of the new San Jose High School, San Jose, Calif. The staircase is supported only at the first floor and at the second floor 11 ft above. Each end is anchored into a heavy slab so that the ends are essentially fixed.

The helicoidal slab has a constant total thickness of 10 in. measured normal to its surface. The design loads were 175 psf for dead load and 75 psf for live load, or a total of 250 psf of horizontal projection.

The reinforcing scheme was kept as simple as possible, as can be seen in the two cross sections of Fig. 1. Longitudinal steel bars of 1-in. diameter, placed so that they were normal to radial sections at all points, were designed in the conventional manner to resist bending moments at all sections. Hoop-type stirrups of $^5/_8$-in. diameter, placed radially, were spaced 9 in. from center to center measured along the center line of the staircase, throughout the entire length of the structure.

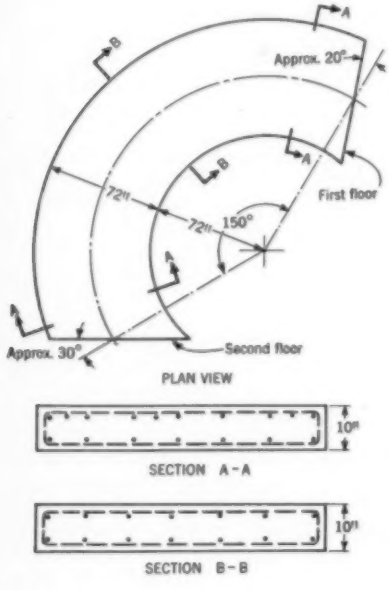

FIG. 1. PLAN VIEW of staircase is shown above sections A-A and B-B. Vertical distance between first and second floors is 11 ft 0 in. Sections indicate position of longitudinal steel bars of 1-in. diameter and radial stirrups, which are $^5/_8$-in.-dia bars spaced 9 in. from center to center.

These stirrups were designed so that the horizontal legs carried the diagonal tension due to the large horizontal torsional shearing stresses at the centers of the long sides of the rectangular section. The vertical legs of the stirrups were more than adequate to take the smaller diagonal tension due to the sum of the direct vertical shearing stresses and the small vertical torsional shearing stresses. The torsional shearing stresses were calculated using the conventional formulas for torsion on rectangular sections.

The entire school project was designed by Ernest J. Kump, architect of San Francisco. Contractors for the job are Carl N. Swenson Co. and Williams & Burrows Co., both of San Jose. The staircase was designed structurally by the writer under the supervision of Eric Moorehead, structural engineer.

A. C. SCORDELIS, Jun. M. ASCE
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Claims Distinction of Being Youngest Junior Ever Admitted to ASCE

TO THE EDITOR: On October 5, 1897, in my nineteenth year, I was elected a Junior in the American Society of Civil Engineers. I feel very proud of having been admitted at that age, and especially proud of having been a Life Member since January 1, 1945.

In the course of a careful search through the memoirs of deceased members in the TRANSACTIONS of the Society, I failed to find a record of any other member's having been elected a Junior at that age. I claim the distinction of being one of the youngest—if not the youngest—Junior ever admitted and, until found wrong, will rest on my laurels.

Well do I remember my first and last meeting at the old Society Headquarters, 127 East 23rd Street, New York, and the formal opening of the new headquarters at 220 West 57th Street, on November 24, 1897, with President Benjamin Morgan Harrod, of New Orleans, La., presiding. Ceremonies were opened with a dedicatory prayer by the Right Reverend Henry C. Potter, and addresses were made by Gen. William Price Craighill, Past President and Honorary Member, J. G. Schurman, President of Cornell University, and the Honorable Joseph H. Choate.

As I look backward with great pleasure on my many years of affiliation with the Society, it would be very difficult for me to express in a few words the many benefits derived from association with those in the same profession and in the same field of interest and from the vast amount of engineering literature received in the form of Society publications.

In my opinion, among the many factors that have contributed to the present greatness of our Society has been the splendid work of our Technical Division committees in establishing theories, standardizing engineering practice, and maintaining ethical standards.

Incidentally, I still have in my possession the official letters from the late ASCE Secretary Charles Warren Hunt, notifying me of my election as Junior on October 5, 1897, and as an Associate (now Affiliate) on May 3, 1910, which I shall keep as cherished mementoes.

THEODORE BELZNER, Affiliate, ASCE
Brooklyn, N.Y.

Example on Artesian Well Drawdown Corrected

TO THE EDITOR: Regarding my article, "Drawdown in Artesian Wells Computed by Nomograph," in the October issue, pages 48–49, the required drawdown in the example, as given both in the text and in Fig. 1, should be 1.85 ft instead of 18.5 ft.

VEN T. CHOW, Assoc. M. ASCE
University of Illinois
Urbana, Ill.

SOCIETY NEWS

Induction of President, Award of Honors, and Expanded Technical Program Feature ASCE Annual Convention

The 1951 Annual Convention, held in New York City, October 22–26, was highlighted by a greatly expanded Technical Division program, which included inaugural sessions of the newly formed Engineering Mechanics Division and extensive cooperative sessions on the New Jersey Turnpike; induction of Carlton S. Proctor as President of the Society; an inspiring talk on the forthcoming ASCE Centennial celebration by Lenox R. Lohr, president of the Centennial of Engineering, 1952, Inc.; and presentation of prizes and awards. The first Annual Convention to be held in New York in October under the new Constitution, the program combined numerous innovations with traditional Annual Meeting features. Most important of the innovations was the week-long program of Technical Division meetings and supplementary inspection trips, the most extensive technical coverage ever arranged by the Society.

Featured at the Wednesday morning session was the presentation of prizes and awards and introduction of new Society officers—the President, two Vice-Presidents, and five Directors. All will take office in January, with the exception of Mr. Proctor, who was inducted into the Presidency at the close of the session. Retiring President Gail A. Hathaway, who presided at the Wednesday morning ceremonies, presented a certificate of appreciation to Past-President Franklin Thomas whose term on the Board of Direction is ending.

The "magnificent opportunity" the 400,000 engineers of our nation possess today to contribute to the cause of civilization was emphasized by President Carlton S. Proctor in his inaugural address. "The profession," he asserted, "is in a unique position to combat false ideologies." Pointing out that through the medium of Engineers Joint Council, engineers are engaged in formulating and expressing the constructive thinking of the profession, Mr. Proctor urged participation of the membership in national affairs at local level through the Local Sections. He also urged the cooperation of the Sections in making the forthcoming ASCE Centennial of Engineering a success. His address is printed elsewhere in this issue.

Lenox Lohr Addresses Membership Luncheon

A plea for the whole-hearted support of the membership in making the Centennial a success was also expressed by Lenox R. Lohr, president of the Centennial of Engineering, Inc., in a stimulating talk on the Centennial given at the annual membership luncheon on Wednesday. The aims of the celebration, Major Lohr said, will be to make known the contributions of the engineer in peace and war; to "personalize" the role of the engineer; and to stimulate interest among young people in engineering as a profession. His address is abstracted elsewhere in the issue.

RETIRING ASCE PRESIDENT GAIL A. HATHAWAY (right) congratulates his successor to presidency, Carlton S. Proctor.

PROF. WILLIAM S. LaLONDE, JR. (right), chairman of committees in charge of highly successful Annual Convention, discusses plans with one of his committee members—Horace A. Vanderbeek, who arranged inspection trips.

Lengthy and Diverse Technical Program

Attesting to the ever-increasing vitality of the Society as an agency for the distribution of technical knowledge to its membership were inaugural sessions of the newly formed Engineering Mechanics Division on Tuesday and an Engineering Mechanics Luncheon the same day. In opening the first session, Prof. L. E. Grinter, chairman of the Executive Committee of the Engineering Mechanics Division, traced the beginnings of the group and its actual formation about a year ago. "Since engineering mechanics is the basic science behind civil engineering," he stated, it has previously been a part of every Division without having actual Division status. Papers presented at the first session ably represented the fields of solid and fluid mechanics into which the general field divides itself. In the feature talk at the luncheon, entitled the "Role of the Engineering Mechanics Division in National and International Affairs," retiring President Gail A. Hathaway stressed engineering mechanics "as a powerful tool in the hands of engineers." Arthur T. Ippen, professor of hydraulics at M.I.T., will be next Division chairman.

A construction phenomenon of modern times—the New Jersey Turnpike—was described in cooperative sessions of five Divisions on Thursday and Friday and in a Construction Division luncheon. Planned and built in only 30 months, the 130-mile highway from southern New Jersey to the George Washington Bridge goes through the highly congested industrial area of northern New Jersey, making it one of the most difficult road-building projects ever undertaken. It was built at a cost of $255,000,000, which makes it also one of the most expensive roads in history. A trip over finished sections of the highway, which will be opened to traffic in January, supplemented the technical program. The New Jersey Turnpike papers will be printed in a later issue.

Of more than usual interest, also, was a national water resources panel discussion that set forth the viewpoints of the President's Water Resources Policy Commission and Engineers Joint Council. Samuel B. Morris, member of the President's Commission, explained the stand of the Commission, which recommends the conservation and development of natural resources through the river basin development of the country. The EJC recommendations—outlined by ASCE Past-President W. W. Horner, chairman of the EJC National Water Policy Panel—place emphasis on the principle that beneficiaries of water-resource developments should make appropriate payments for benefits received, and stress the "necessity for impartial analysis of projects." Both agencies urge formation of a national water policy.

ASCE OPERATION at Local Section level is discussed in two-day conference of representatives from 25 Local Sections in the northeastern area on October 22-23.

ANNUAL CONVENTION REGISTRATION of over 1,800 includes Student Chapter representatives from South Dakota State College—Ivan M. Borgen (left), vice-president of Chapter, and William G. Borghard.

Civil-Military Liaison Meeting

How the civil engineer can best aid in the defense program was brought out by the engineering heads of the three armed services in a general Civil-Military Liaison session on Wednesday afternoon. Speakers were Lt. Gen. Lewis A. Pick, Chief of Army Engineers; Brig. Gen. Colby M. Myers, staff engineer, Strategic Air Command; and Rear Admiral Joseph F. Jelley, Jr., chief of the Bureau of Yards and Docks. The talks revealed new problems in runway design posed by the tremendously increased weight of modern aircraft; the need for lifting and loading equipment "with capacities not dreamed of in commercial operation"; the need for improved types of surfacing; problems involved in the design and construction of floating drydocks; and the necessity of further research into effective use of precast and prestressed concrete for many types of military and naval structures. The final paper in the symposium—by President Carlton S. Proctor, New York City consultant—explored the role of the civilian engineer in the defense mobilization program.

Notable Social Program

The annual dinner dance program on Wednesday evening was highlighted by the award of honorary membership to four engineers—an event usually scheduled for the Wednesday morning meeting—and presentation to the Society of a "White House Gavel," made from timbers of the original building, in recognition of the contribution of the profession to the White House reconstruction work. The presentation was made by ASCE Past-President Richard E. Dougherty, a member of the President's Commission on the Renovation of the White House. Mr. Dougherty reminisced interestingly on his experiences as a member of the Commission.

The interior decoration of the White House was described to the visiting ladies at a breakfast in the Charleston Gardens of B. Altman & Co., who are in charge of furnishings and decorations. This event was part of an exceptional week-long program arranged for the women of the party by a committee of Metropolitan Section wives under the chairmanship of Mrs William S. LaLonde, Jr.

Local Section and Student Conferences Held

The many other events of Annual Convention week included a two-day Local Section Conference of representatives in the Northeast area, who discussed Section operation; a Student Chapter Conference, sponsored by the Metropolitan

TEXAS IS WELL REPRESENTED at Annual Convention. Shown in left-hand photo (left to right) are Prof. Raymond R Dawson, associate director of Research Laboratory at University of Texas; Israel W. Santry, Jr., secretary-treasurer, Texas Section; and Raymond R. Sartain, superintendent of construction, Gulf Oil Corp., Houston. Left-center view shows L. E. Grinter (center), chairman, Executive Committee, Engineering Mechanics Division, chatting with two speakers on Division's inaugural session program—H. L. Dryden, director of aeronautical research, National Advisory Committee for Aeronautics, Washington, D.C., and J. N. Goodier, professor of theoretical and applied mechanics, Stanford University.

EXCEPTIONAL LADIES' PROGRAM for Annual Convention was handled by Ladies' Committee headed by Mrs. William S. LaLonde, Jr. (seated, center) as chairman. With her are, left to right, Mrs. Charles E. Trout, Mrs. Raymond L. Brandes, vice-chairman, Mrs. La Londe, Mrs. John Riley, and Mrs. Alfred Hedefine. Standing in same order are, Mrs. Richard H. Tatlow III, Mrs. Richard Hazen, Mrs. George W. Burpee, Mrs. William N. Carey, Mrs. Maurice Quade, and Mrs. Waldo G. Bowman.

Conference of Chapters and featuring a talk on the critical manpower situation; a smoker for the men; and a wide choice of inspection trips and excursions.

Registration Is High

The registration of over 1,800 included members from Puerto Rico, Hawaii, Mexico, the British West Indies, Brazil and Canada and students who came at their own expense from Chapters in far-off parts of the country. Prof. William S. LaLonde, Jr., as chairman, and Raymond L. Brandes, as vice-chairman, headed committees responsible for the memorable Convention.

Board of Direction Actions at New York Briefed

Meetings of the Board of Direction took place in the Society's Board Room in New York on October 22, 23 and 25. Gen. Edward C. Dohm, of Olympia, Wash., was appointed as Director of District 12 to succeed the late Walter J. Ryan and to serve out his unexpired term.

1952 Budget Adopted

A balanced budget for the fiscal year 1952 to a total of $856,716 was adopted.

Executive Committee Meetings

A policy was adopted instructing the Executive Committee to meet between Board meetings at times approximately midway between regular meetings of the Board, the places and dates to be selected by the President, who is chairman of the Committee.

ASCE Publicity for Centennial Celebration

The Board of Direction authorized the Executive Committee to take all necessary steps to insure that adequate publicity be obtained for the ASCE part in the coming centennial celebration of one hundred years of engineered progress scheduled for Chicago, Ill., next year.

Redistricting to Be Studied

The subject of redistricting was considered, and it was decided that the matter be given continued study by the Committee on Districts and Zones.

Technical Divisions

A proposal recommended by the Committee on Division Activities for the formation of a Technical Division on Engineering Management and the concurrent dissolution of the Division of Engineering Economics was referred back to the Committee on Division Activities for additional study and report. Immediately prior to the meeting of the Board of Direction, a petition was received requesting the formation of a Technical Division on Professional Practice. The petition was referred to the Executive Committee for study and recommendation.

Authorization was given for a conference of the Hydraulics Division at the University of Minnesota Hydraulics Laboratory at Minneapolis early in September 1953.

Compilation of ASCE Rules Approved

A compilation of Society Rules and Procedures supplementing its By-Laws, as proposed by the Committee on Organization, Constitution and By-Laws, under the chairmanship of A. W. Harrington, was approved.

Unification Plan Endorsed

Upon recommendation of its representative on the EJC Exploratory Committee for Increased Unity of the Engineering Profession, the Board of Direction endorsed the so-called Unification Plan "A," subject to minor modifications and to later detailed consideration when a definite plan is finally submitted to the Board of Direction by the EJC Unity Committee.

Defense Bonds

Upon request of the United States Treasury Department, the Board authorized the President to appoint an ASCE National Bond Chairman to assist the Treasury Department in a direct mail solicitation for the purchase of Defense Bonds by members of the Society.

ASCE Representatives Appointed

The Board concurred in the appointment of Dean Thorndike Saville to succeed the late Dr. Boris A. Bakhmeteff as chairman of the ASCE Committee on Research and as a representative of ASCE on the Engineering Foundation Board.

Waldo G. Bowman, of New York, was appointed new member of a three-member ASCE representation on United Engineering Trustees, the body that owns and operates the Engineering Societies Building in New York.

Formation of District Councils Recognized

Official recognition was given to the formation of a District Council of the Local Sections in District 10 and similarly a Council in District 6.

Formation of Alaska Section Approved

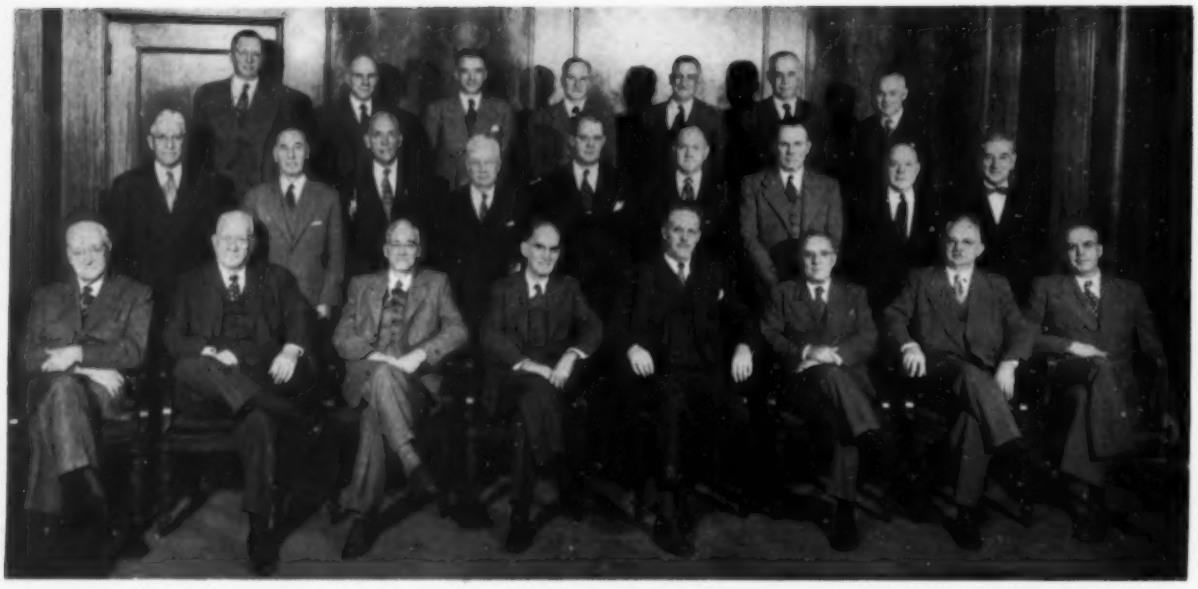
A petition for the formation of an Alaska Section of the Society was approved by the Board of Direction.

Utilization of Sanitary Engineers

A proposed active program by the Sanitary Engineering Division looking toward better utilization of sanitary engineers was approved.

Junior Members

Among the recommendations made by the Committee on Junior Members, the Board approved the adoption of a policy that every Local Section should be requested to appoint at least one Junior Member on each of its committees which consist of three or more members, and



INCOMING BOARD OF DIRECTION is photographed at ASCE Headquarters during Annual Convention. In front row, left to right, are Charles E. Trout, Treasurer of Society; A M Rawn, Vice-President, Zone IV; Daniel V. Terrell, Vice-President, Zone III; William R. Glidden, Vice-President, Zone II; ASCE President Carlton S. Proctor; Past-President Gail A. Hathaway; Past-President Ernest E. Howard; and William N. Carey, Executive Secretary, ASCE. Second row shows Isaac C. Steele, Director, District 11; Walter D. Binger, Director, District 1; Frank A. Marston, Director, District 2, Louis R. Howson, Director, District 8; G. Brooks Earnest, Director, District 9; Norman R. Moore, Director, District 14; Burton G. Dwyre, Director, District 15; Kirby Smith, Director, District 1; and Edward C. Dohm, who will replace the late Walter J. Ryan as Director for District 12. In top row are Wallace L. Chadwick, Director, District 11; James A. Higgs, Director, District 10; Milton T. Wilson, Director, District 11; Gordon H. Butler, Director, District 7; Frank L. Weaver, Director, District 5; Morris Goodkind, Director, District 1; and Otto Holden, Director, District 3. Not photographed are George W. Burpee, new Vice-President, Zone I, and George W. McAlpin, new Director, District 6. Except for President Proctor, who was inducted into office during Convention, new officers do not go on Board until January 1952.

also that each Local Section turn over to its Junior Members complete responsibility for at least one regional Local Section meeting a year.

Committee Appointments

The Board of Direction, on recommendation of the incoming President, Carlton S. Proctor, recommended appointment of certain standing committees for the year. These will be listed in a forthcoming issue.

Europe–United States Engineering Congress

The third biennial meeting of engineering societies of the United States and western Europe, held at The Hague, September 17–21, in the building of the Royal Institute of Engineers of Holland, was attended by 23 delegates representing 14 national engineering societies. The conference adopted as its name the Europe–United States Engineering Congress (EUSEC).

Actions of immediate interest to engineers in the United States included: An attempt to arrive at acceptable definitions of the terms, "professional engineer" and "engineering technician"; steps to establish a service for abstracting engineering publications; and efforts to assure the close cooperation of EUSEC with somewhat similar international conferences, such as the Conference of Engineering Institutions of the British Commonwealth and the Conference of Engineering Societies of the Western Hemisphere (UPADI).

Representatives of the following engineering societies were in attendance: Société Royale Belge des Ingénieurs et des Industriels, Belgium; Dansk Ingeniorforening, Denmark; Suomalaisten Teknikkojen Seura and Tekniska Föreningen i Finland, Finland; Société des Ingénieurs Civils de France, France; Koninklijk Instituut van Ingenieurs, Holland; Den Norske Ingeniorforening, Norway; Svenska Teknologföreningen, Sweden; Schweizerischer Ingenieur- und Architekten-Verein, Switzerland; the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Electrical Engineers, United Kingdom; and American Society of Civil Engineers, American Society of Mechanical Engineers, and American Institute of Electrical Engineers, United States.

Delegates from the United States were W. N. Carey, Executive Secretary, ASCE; Clarence E. Davies, Secretary ASME; and Prof. E. O. McMillan, President, and H. H. Henline, Secretary of AIEE. The invitation of the Société des Ingénieurs Civils to hold the next meeting of EUSEC in Paris during 1953 (probably in September) was accepted.

ASCE Yearbook for 1952 Must Be Requested

As announced in the October issue, the new Yearbook membership list, which is being processed for publication in January 1952, will be available without charge to all Society members. However, in the interests of economy, the new two-year edition will be mailed only to members specifically requesting it. The size of the edition will be determined by the number of requests received. To facilitate ordering, a coupon has been provided on page 80. Copies will be distributed automatically to officers of the Society and to Local Sections.

Plans for Centennial of Engineering Take Shape

Plans for observing the one hundredth anniversary of the founding of ASCE, to be held in Chicago during 1952, have taken another step forward with the appointment of Frank W. Edwards, M. ASCE, director of the department of civil engineering at Illinois Institute of Technology, as general manager of the Centennial of Engineering, 1952, Inc.

Selection of Mr. Edwards, who has been granted a leave of absence to direct the celebration which will be of international proportions, is announced by Lenox R. Lohr, M. ASCE, president of Centennial of Engineering, 1952, Inc. In his capacity with the Centennial, Mr. Edwards will coordinate a program that includes a five-year exhibit of significant engineering achievement, to be staged at the Museum of Science and Industry; a summer-long pageant that will tell the story of engineering to the public; and a convocation, culminating feature of the celebration, to be held during the period, September 3 to 13, 1952.

To direct the over-all phases of the celebration, a special not-for-profit corporation, Centennial of Engineering, 1952, Inc., has been created, with headquarters at the Museum of Science and Industry in Chicago. Major Lohr, president of the museum, is also president of the corporation. Charles F. Kettering, Hon. M. ASCE, director and research consultant for General Motors, is chairman of the executive committee.

Named as convocation manager is E. L. Chandler, Assistant Secretary of ASCE. Heads of two committees to coordinate activities of the numerous participating societies have also been selected. They are Howard F. Peckworth, M. ASCE, managing director of the American Concrete Pipe Association, Chicago, who is chairman of the coordinating committee on general arrangements, and G. Donald Kennedy, M. ASCE, assistant to the president of the Portland Cement Association, who has been named chairman of the coordinating committee on technical programs.

In announcing full-scale launching of plans, Major Lohr reports that 41 national and international engineering groups are already planning active participation, and that at least 30 others will hold special meetings or send token delegates. Both the Department of State, through its Division of International Conferences, and the ECA have expressed the intention of encouraging attendance from foreign countries.

Each participating society will arrange and finance its own meeting. Financing of the general phases of the convocation will be the responsibility of the corporation. Sizable contributions have already been received from many of the country's leading industrial companies. The final budget may reach $1,000,000.

Program Will Have Wide Public Appeal

With the objective of making the Centennial "a means of awakening the public to all that engineering has meant not only in industry but in every other sphere of physical progress over the past century," the entire Centennial celebration will be presented in terms readily comprehensible to the average layman. Each subject will be developed with appreciation of its social and economic aspects and its dramatic appeal.

FRANK W. EDWARDS
General Manager of Centennial

The exposition, which will be installed in the Museum of Science and Industry, will supplement with new engineering exhibits what is widely recognized as the world's finest collection in the fields of science, engineering, and industry. Special committees have been appointed in the major societies to advise as to appropriate exhibits. The exposition will be opened to the public in July 1952 free of charge and remain for at least five years.

The role of engineering in building a better world will be dramatically unfolded in the pageant, to be presented during the entire summer in the 1,000-seat theater in the Museum of Science and Industry. A cast of more than 150 actors will depict engineering episodes and developments that have contributed greatly to human progress. The scenes will be chosen on the basis of their dramatic appeal from more than 100 such events now under consideration.

Convocation to Be Held in September

The convocation, climax of the year-long celebration, is expected to bring together the greatest gathering of engineers ever assembled. It will be held in Chicago during the period, September 3 to 13, 1952. Symposium sessions are scheduled for each day of the convocation period. The subjects will cover a wide variety of engineering and industrial accomplishment, and presentations will be sufficiently non-technical to be of educational value to the general public as well as to engineers. In addition, the individual societies participating will hold meetings of their own, with technical sessions devoted to their particular field of engineering. There will be joint technical sessions for subjects in which two or more societies have a particular mutual interest.

Participating Societies

Societies that are already planning to participate include, in addition to the five Engineers Joint Council constituent societies, those listed in the accompanying box.

- American Association for the Advancement of Science
- American Concrete Institute
- American Society of Agricultural Engineers
- American Iron and Steel Institute
- American Standards Association
- American Rocket Society
- American Welding Society
- American Meterological Society
- American Foundrymen's Association
- American Society of Tool Engineers
- American Society for Engineering Education
- American Institute of Consulting Engineers
- American Society for Testing Materials
- American Association of Engineers
- American Railway Engineering Association
- American Society of Safety Engineers
- Boston Society of Civil Engineers
- Edison Electric Institute
- Engineers Council for Professional Development
- Engineering Institute of Canada
- Franklin Institute
- Industrial Management Society
- Institute of Traffic Engineers
- International Association for Hydraulic Research
- International Commission on Irrigation and Drainage
- International Commission on Large Dams
- National Conference on Industrial Hydraulics
- National Society of Professional Engineers
- Society for the Advancement of Management
- Society of American Military Engineers
- Society of Naval Architects and Marine Engineers
- Society of Automotive Engineers
- U. S. Council of the International Association for Bridge and Structural Engineering
- Western Society of Engineers
- World Power Conference
- Chicago Section of the American Chemical Society

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

Legislation

The eighty-second Congress reached the half-way mark and suspended deliberations for the rest of 1951. Several important pieces of legislation were enacted in the closing days of the first session.

The Foreign Aid Program (H.R. 5113) was enacted into law as P.L. 165, the Mutual Security Act of 1951. A $7.4 billion Economic and Military Aid Program was authorized. A new agency, the Mutual Security Administration (MSA), responsible for coordinating all foreign-aid programs, was established. W. Averell Harriman was nominated and confirmed as director. MSA takes over the functions of the Economic Cooperation Administration, which is to be abolished, effective June 30, 1952. The Defense Department will continue to handle the procurement and supply of military equipment used in the military-aid program, and the Secretary of State will continue the immediate administration of the Point IV technical assistance program. A $7 billion appropriation bill was passed to implement this law.

The lending authority of the Export-Import Bank is increased by $1 billion by P.L. 158 (signed October 3).

Included in the last-minute legislation was the act (S. 662) providing a pay raise of about 10 percent for federal employees with a minimum raise of $300 and a maximum limit of $800.

P.L. 155, signed on September 28 (H.R. 4914), authorizes a $5.8 billion military-construction program in the United States and at overseas bases. This includes a $3.5 billion program for the Air Force to build new air bases and to widen and lengthen existing runways—$415 million is for overseas bases. The Army program of $1.4 billion includes $175 million for overseas construction. The Navy program of $832 million includes $90 million for overseas construction. Certain projects will be undertaken jointly by the three services. A $4 billion appropriation was made to implement this legislation.

A House Appropriations Subcommittee rejected proposals for a waterway to connect the Tennessee River with the Gulf of Mexico as an alternate to the Mississippi River. The House Interior Committee voted to take no further action on bills (S. 75, etc.) relating to the Central Arizona Project until February 1, 1952. The House Public Works Committee postponed indefinitely a final vote on H. J. Res. 337 authorizing United States participation in the St. Lawrence Seaway and Power Project. The Chief of Engineers gave the latest cost estimate as $818 million.

S. 921, passed by both houses and sent to the White House for signature, authorizes the Comptroller General to examine data relating to contractors and subcontractors whose contracts were not obtained by competitive bidding (with a three-year review limitation).

Bills previously mentioned in this column on which no final action was taken include H.J. Res. 218, relating to air pollution research; S. 1134–1151, inclusive, implementing the Hoover Report; S. 1144 (H.R. 3318), providing for a board of impartial analysis for engineering and architectural projects; H.R. 1636, an accelerated mapping program; H.R. 2752 to encourage the prevention of water pollution through rapid amortization of new facilities; and H.R. 5079 to establish a Missouri Valley Authority.

NPA Regulations

NPA press release 1266, dated September 24, 1951, is basic to an understanding of the construction control regulations mentioned in CIVIL ENGINEERING for September. It gives 71 interpretations and illustrations of the regulations and clears up several matters not entirely settled by them.

According to the most recent pronouncements, if a builder has materials on hand or at a mill for delivery to him but requires additional quantities of critical materials in excess of the amounts permitted for self certification, he must have received an allotment for the needed materials in order to continue construction. However, he may continue construction if the added amounts are within the prescribed limits for self certification for the type of structure involved.

The fourth quarterly allotment of steel by DPA brought forth protests from claimant agencies which suffered serious cuts in their requests. The allegedly over-drastic cuts in steel for highways and for school construction led to Congressional hearings. More considered treatment for these essential fields may result. Serious consideration will be given to the question of whether such cuts are really essential. The Bureau of Public Roads has requested that highways be classified as industrial projects. This would permit steel to be obtained in amounts up to 25 tons for small bridges through the self-certification procedure.

Based on a report by top executives of the steel industry, DPA has asserted that the requirements for structural shapes stated by the claimant agencies are unrealistic and exaggerated, totaling for the fourth quarter, an amount more than double the all-time record quarterly supply and indicating an annual rate of consumption nearly double the record war year output.

DPA believes that the rate at which projects can be designed, fabricated and erected has not been properly taken into consideration. Action is being taken under the latest regulations to eliminate excessive inventories of the critical metals. For example, all material shipped after October 7 on third-quarter quotas must be charged to the fourth quarter.

A meeting of construction industry groups will be held early in November to consider the situation.

Each segment of the construction industry has its own spokesman on the Requirements Committee of DPA. No one person views the needs of construction as a whole. The question has been raised as to whether a high-level over-all adviser on construction in DPA might be essential.

World Bank Report

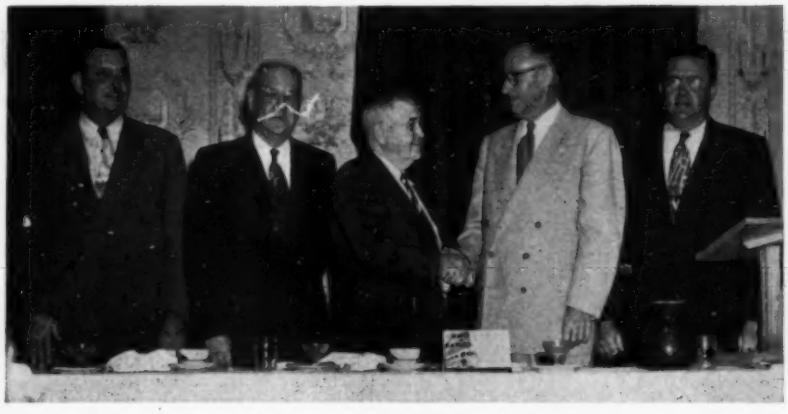
The Sixth Annual Report of the World Bank showed effective loans outstanding, held by the bank, of slightly over $1 billion to 20 countries, of which $690 million has already been disbursed. Twenty-one new development loans, made during the past fiscal year and emphasizing improvement of electric power supply, transportation, flood control, and irrigation, total $297 million. Other future loans have been approved. Reconstruction loans outstanding to Denmark, Ethiopia, France, India, Iraq, Luxemburg, Netherlands, South Africa, Thailand, and Turkey represent operations involving civil engineering work.

Washington, D.C.
October 26, 1951

ASCE MEMBERSHIP AS OF OCTOBER 9, 1951

Members	7,960
Associate Members	10,132
Junior Members	14,980
Affiliates	66
Honorary Members	37
Fellows	1
Total	33,176
(October 9, 1950	30,108)

BRAZIL SECTION MEMBERS hear Carlton S. Proctor, newly elected President of ASCE, at recent dinner meeting. Colonel Proctor discussed forthcoming Centennial Celebration of ASCE and urged attendance of Brazilian engineers. Shown with him are, left to right, John T. Howell, secretary; Dr. F. Saturnino R. de Brito, Jr.; Paul L. Heslop, president; and Prof. Mauricio Joppert da Silva, of Escola Nacional de Engenharia.



GEORGE H. LACY (second from right), retiring president of Houston Branch of Texas Section, congratulates his successor to presidency, Charles R. Haile. Shown, left to right, are T. Spence Love, Houston Branch director to Texas Section; A. S. Hatch, vice-president, Houston Branch; Messrs. Haile and Lacy; and R. A. Rait, secretary and treasurer.

ATTENDING RECENT DINNER MEETING OF WEST VIRGINIA SECTION, held at Keyser, W.Va., are (left to right) William Brewster, Section president; Paul L. Holland, ASCE Director for District 6; Rear Admiral Harold W. Johnson, of Fifth Naval District, who was principal speaker; W. R. Glidden, ASCE Vice-President for Zone II; J. P. Blundon, chairman of committee on meeting arrangements; and R. C. Quinn, Section vice-president. Preceding meeting, group inspected new Keyser-McCoole Bridge between Virginia and Maryland and Amcelle plant of Celanese Corporation of America.

Coming Local Section Events

Arizona—Annual fall meeting at the Adams Hotel, Phoenix, November 23 and 24.

Buffalo—Meeting at the Buffalo Athletic Club, November 20, at 12:15 p.m.

Central Ohio—Dinner meeting at the Chittenden Hotel, Columbus, November 20, at 6:15 p.m.

Cleveland—Dinner meeting at the Cleveland Engineering Society on November 16, at 6:15 p.m.

Colorado—Meeting at the Democratic Club, Denver, November 12, at 6:30 p.m.

District of Columbia—Meeting in the Cosmos Club Auditorium, Washington, November 13, at 8 p.m.

Illinois—Weekly luncheons every Friday at the Chicago Engineers Club, at 12 noon.

Kansas City—Annual meeting at the Wishbone Restaurant, Kansas City, on December 4.

Los Angeles—Sponsored by the Junior Forum, an inspection trip will be made to the Statler Center Hotel and office building in Los Angeles on November 17, at 10 a.m.

Louisiana—Meeting in New Orleans on November 26.

Maryland—Meeting at the Engineers Club of Baltimore, November 14, at 8 p.m., preceded by cocktails at 6 p.m. and dinner at 7 p.m.

Metropolitan—Meeting, arranged by Junior Branch, in the Engineering Societies Building on November 28, at 8 p.m. Junior Branch dinner meeting on November 14.

Mexico—Meeting at the University Club, Mexico, D.F., November 13, at 8 p.m.

Mid-South—Annual meeting of Section in Little Rock, Ark., on December 7 and 8. Dinner meeting of Jackson Branch of Section at the Hotel Heidelberg, Jackson, November 29, at 7 p.m.

Mohawk-Hudson—All-day meeting in the State Office Building, Albany, November 17.

Montana—Meeting of Hungry Horse Branch at the USBR Conference Hall, Hungry Horse, November 14, at 8 p.m.

Northwestern—Dinner meeting in the Junior Ballroom of Coffman Memorial Union, University of Minnesota, Minneapolis, on December 3. Meeting of the South Dakota Branch of Section in Sioux Falls, S.Dak., December 6–8.

Oklahoma—Annual meeting at Norman, Okla., on November 30 and December 1.

Philadelphia—Meeting at the Engineers Club, Philadelphia, November 13, at 7:30 p.m., preceded by dinner at 6 p.m.

Pittsburgh—Joint meeting with Pittsburgh section of Engineers Society of Western Pennsylvania at the Hotel William Penn on November 20, at 8 p.m.

Tennessee Valley—Annual meeting to be held in Knoxville, Tenn., November 16 and 17, under auspices of Knoxville Sub-Section. Meeting of Muscle Shoals Sub-Section on November 15, at 6:30 p.m.

Virginia—Joint meeting with Engineers Club of Hampton Roads on November 14.

West Virginia—Annual meeting at the Daniel Boone Hotel in Charleston, Novem-

ber 16 and 17. Principal speaker at the dinner meeting Friday, November 16, will be ASCE President Carlton S. Proctor.

Florida Section Forms Southwest Sub-Section

Formation of a second Sub-Section in southwest Florida is announced by C. D. Williams, president of the Florida Section. Nearly 100 members of ASCE residing in the area will be served by the new organization, which will have its headquarters in Tampa. Officers of the new Sub-Section are Nathan Grant, president; J. C. O'Brien, vice-president; and Homer Hughes, secretary-treasurer.

Another Sub-Section of the Florida Section, with headquarters in Gainesville, has been in successful operation for two years, with a marked increase in attendance of members at ASCE functions and applications for membership from the area.

Member Benefits from Group Insurance Plan

Attesting to the value of the group disability insurance plan adopted by the Board of Direction over two years ago is a recent letter from Millard P. Snyder, Jun. M. ASCE, to Smith and Sternau, administrators for the plan. Only three days after receiving a group disability contract, Mr. Snyder was seriously injured in an automobile accident that incapacitated him for a number of months.

He writes, "The disability policy that I obtained three days before the misfortune that befell me was certainly a wonderful thing—paid me a bit over $2,000. My dealings with the company were entirely satisfactory."

News of Local Sections Briefed

SECTION	DATE	ATTENDANCE	PROGRAM
Florida Gainesville Sub-Section	September 27	...	Dinner meeting. A. O. Patterson, district engineer, Surface Water Branch, U.S.G.S., at Ocala, Fla., and Prof. D. A. Firmage, of University of Florida, were elected president and secretary-treasurer, respectively, to fill unexpired terms of Professors L. J. Ritter and F. Bromilow (See "News of Engineers" department elsewhere in this issue).
Mid-South	September 6–7	...	Fall meeting featuring business and technical sessions, inspection trips to Greenville, Miss., harbor and sewage pumping stations, now under construction, and evening banquet. Community development was theme of technical session with papers presented by John H. Teunisson, Jr., city engineer of Greenville; Charles R. Sayre, president and managing director of Delta & Pine Land Co., at Scott, Miss.; John A. Fox, civil engineer, Inland Waterways Authority; Hodding Carter, editor and publisher of Greenville. ASCE Vice-President Daniel V. Terrell and Director Norman R. Moore spoke on Society affairs.
Jackson Branch	September 27	20	Dinner meeting. Film on steel construction was shown.
Northwestern	October 1	29	An illustrated talk on the status of housing and redevelopment in St. Paul was given by William B. Randall, chairman of St. Paul Housing and Redevelopment Authority.
Oklahoma	September 21	...	Fall meeting. Chuck O'Connor, executive vice-president of Associated Industries of Oklahoma was luncheon speaker. Topics of technical sessions included floods, Oklahoma City waterworks improvements, and engineering in Central and South America. Col. E. G. Herb, district engineer, Corps of Engineers, Tulsa, Okla., District, M. W. DeGeer, assistant chief, engineering division of District, and Donovan P. Grosshans, special assistant to district engineer; Edward Stapley, dean of engineering, Oklahoma A. & M. College; Charles E. Bretz, consulting engineer of Oklahoma City; and Governor Johnston Murray were speakers.
Tacoma	October 9	63	Bennett Saunders and Robert Locks, field engineer and structural engineer for Portland Cement Association, respectively, talked on current practices in tilt-up precast concrete buildings. Showing of film on "Great Lakes Tilt-up Housing Project" concluded program.

Scheduled ASCE Conventions

NEW ORLEANS CONVENTION
New Orleans, La., March 5–7, 1952

DENVER CONVENTION
Denver, Colo., June 16–20, 1952

CENTENNIAL OF ENGINEERING
Chicago, Ill., September 3–13, 1952

GROUP OF SAN FRANCISCO SECTION MEMBERS inspect city's Broadway Tunnel Project, objective of recent Section field trip. Job is under jurisdiction of Ralph Wadsworth (with roll of plans), San Francisco city engineer, and S. P. Duckel (shown fifth from left), San Francisco public works director. Harry Kirmond, assistant project manager for Morrison-Knudsen Company, contractors, briefed group on job.

NEWS BRIEFS . . .

Construction Curbs Discussed at APWA Congress

Public works officials attending the 1951 Congress of the American Public Works Association, held recently in Detroit, Mich., were urged "to put the brakes on construction projects" by James W. Follin, M. ASCE, Defense Production Administration official. Speaking at a widely attended general session, Mr. Follin emphasized the fact that steel and copper are in critically short supply and pointed out that "only 51 percent of the materials needed to increase our steel production is in sight."

Edward J. Cleary

Several sessions were devoted to discussion of highway safety, with Pyke Johnson, president of the Automotive Safety Foundation, leading a technical session on the subject. At the annual banquet Milton Rosen, retiring president of the APWA, also discussed the topic further, emphasizing the need for highway construction materials to make safe driving possible.

Another feature of the banquet, which was attended by more than 400, was the presentation of honors and awards. ASCE Members receiving Samuel A. Greeley Service Awards for "thirty years of continuous service to their municipalities and long-standing membership in the APWA" included Morris M. Cohn, John S. Flockhart, and Wendell R. LaDue. William A. Xanten, superintendent of the Washington, D.C., Division of Sanitation, was named first recipient of the Charles Walter Nichols Award for "outstanding achievement in the field of sanitation."

In a resolution passed during the meeting, the Association urged Congress to set up on a permanent basis a system for making "adequate federal aid immediately available for rehabilitation and overcoming local public loss to any area suffering flood damage where control facilities are under federal government jurisdiction." Another resolution urged provision of federal funds for "the purpose of implementing and carrying out a broad, protective, well-balanced, and properly organized civil defense program." Reaffirming the action taken at its 1950 Congress, the group also petitioned, "that federal priorities be given on all materials and supplies necessary to public works construction and maintenance on a level commensurate with their importance and in accordance with the recognized value to our democratic way of life of maintaining the municipal functions of the cities of the nation."

During the business meeting Edward J. Cleary, M. ASCE, executive director of the Ohio River Valley Water Sanitation Commission, was elected president for the coming year to succeed Milton Rosen. New vice-presidents elected for two-year terms are Allan H. Rogers, superintendent of public works, Garden City, N.Y., for the Eastern region, and Milton Offner, secretary of the Los Angeles Board of Public Works, for the Western area. Holdover vice-presidents for the Central and Southern areas are George R. Thompson, M. ASCE, city engineer of Detroit, and Warren A. Coolidge, director of public works, Nashville, Tenn. Edward P. Decher, secretary and purchasing agent, Joint Sewer Commission, Newark, N.J., was elected treasurer, and J. J. Dean, construction superintendent of Albany, Ga., was named director of the Association for a two-year term.

Port Authority to Have Rio de Janeiro Office

Establishment by the Port of New York Authority of a New Jersey–New York port trade promotion office in Rio de Janeiro, Brazil, is announced. Robert L. Mills, Jr., of Rio de Janeiro, will be manager of the office, which will open November 15. In recent years the Port Authority has established similar offices in Chicago, Cleveland, and Washington to help promote the movement of world commerce through the Port of New York.

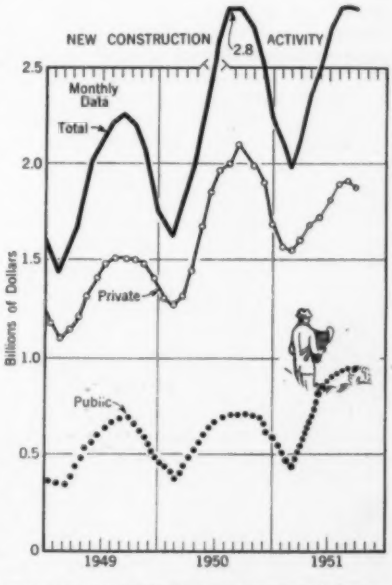
Construction Activity Drops Slightly in September

A slight drop in construction activity in September is reported jointly by the Building Materials Division of the U.S. Department of Commerce and the U.S. Labor Department's Bureau of Labor Statistics. The decline is attributed to curtailed outlays for most types of private building and public works resulting from current building restrictions and materials shortages. Continued expansion in factory building, military construction, and public housing is noted.

The total value of new construction put in place during September amounted to more than $2.8 billion, 1 percent less than the totals for August of this year and for September 1950. Total private outlays of $1,860 million were off 2 percent from the August level and 11 percent from a year ago. Total public expenditures for new construction in September, amounting to $966 million, were 2 percent greater than in August and 28 percent above public outlays in September of last year before military and defense plant construction had gotten under way.

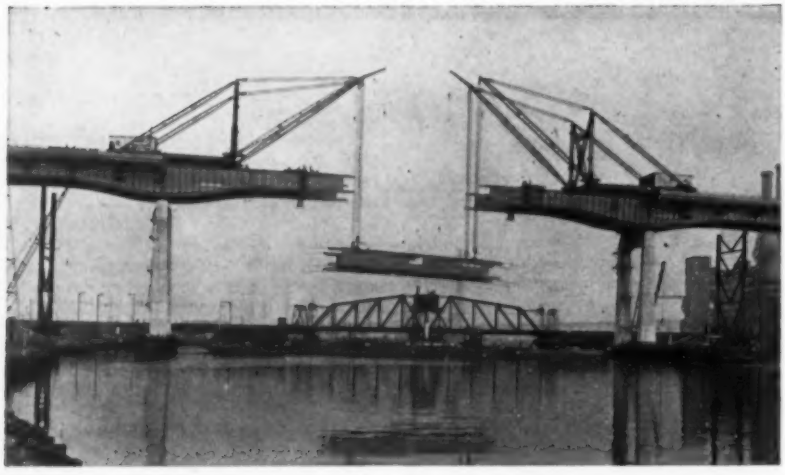
Private homebuilding activity appears to have been stabilized for the time being at about two-thirds of the 1950 record level, according to the joint agencies. Commercial building dropped this September, with work consisting largely of completing projects started before current restrictions were applied, and new projects requiring only limited amounts of steel and copper. Highway construction and other public work declined.

In the first nine months of 1951, total outlays for new construction were in excess of $22 billion, an increase of more than 10 percent over the total for the same period last year. Industrial expansion and the rising volume of military construction, together with increased commercial and institutional building, so far this year have maintained over-all construction activity at record levels despite the drop in private homebuilding.



SLIGHT DECLINE IN SEPTEMBER CONSTRUCTION ACTIVITY is indicated in Department of Commerce Curves.

Closing Girders Are Placed in Passaic River Bridge



ERECTION OF CLOSING GIRDERS in New Jersey Turnpike Authority's Passaic River Bridge is shown here. Girders were placed simultaneously by Bethlehem Steel Company, contractor on the fabricated steel superstructure of the bridge, using the four booms of the two travelers. The closing girders, weighing 146 tons each with wet-plate length of 115 ft, were shipped by rail to the Jersey City area and from there moved by car float. Ammann & Whitney, consulting engineers of New York, are designers and supervisors of erection of the bridge, which has span of 375 ft between river piers. Photo courtesy Ammann & Whitney.

Railroad to Tap Labrador Iron Ore Deposit

In a cold, primitive territory in the Knob Lake–Burnt Creek district of Labrador (shown in Fig. 1), 320 air miles north of the St. Lawrence River, lies a tremendous body of rich iron ore. Since the deposit is inaccessible except by air, the Iron Ore Company of Canada is rushing construction of the Quebec, North Shore & Labrador Railway to bring the ore south to the port at Seven Islands, P.Q., already a town of 3,000, on the St. Lawrence River opposite the Gaspé Peninsula. Destined to augment the output of the Mesabi Range in Minnesota, the ore will be transported in ore boats from docks to be built at Seven Islands to United States ports on the Great Lakes and the Atlantic seaboard.

Construction of the 359-mile railroad has been under way since November 1950, when a $25,000,000 contract was awarded to a joint-venture contracting group consisting of Fred Mannix & Co. Ltd. (sponsor) and the McNamara Construction Co., Ltd., both of Toronto, Cartier Construction Ltd., of Montreal, and the Morrison-Knudsen Co. of Canada Ltd., of Vancouver. James G. Pickard is general manager, and W. E. Ross is chief engineer of the contractors' operations. Contractors have flown in their men and equipment. Scores of tractors, shovels, draglines, and dump trucks, heavy tunnel-driving equipment and 2,000 construction men have been strung out in a dozen camps over the first 100 miles of the line. This year's schedule includes excavation of 5,500,000 cu yd, nearly half of which is rock. Next year 175 miles of track will be laid.

The route for the railroad was selected from studies of aerial photographs and maps. Consultants on engineering and construction of the Q.N.S. & Labrador Railway are Coverdale & Colpitts, consulting engineers of New York; Stone & Webster Engineering Corp., Boston, and Sanderson & Porter, New York.

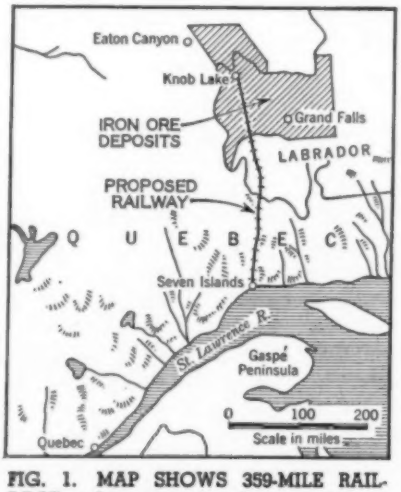


FIG. 1. MAP SHOWS 359-MILE RAILROAD under construction for transportation of Labrador ore to tide water.

The Iron Ore Company of Canada has been formed by the following American and Canadian companies: Hollinger Consolidated Gold Mines, Ltd., Hanna Coal & Ore Corp., Armco Steel Corp., National Steel Corp., Republic Steel Corp., the Youngstown Sheet & Tube Co., Wheeling Steel Corp., Labrador Mining & Exploration Co., and Hollinger North Shore Exploration Co. W. H. Durell is general manager and Hector MacNeil is chief engineer for the owners. Frank C. Wardwell, M. ASCE, represents the engineering consultants on the project.

Progress to date includes a 2,250-ft tunnel, 4,000,000 cu yd of excavation, some from cuts with slopes 200 ft deep, and some bridge and track construction. Grade is completed for the 50 miles of track, and track-laying is in progress. Beyond rail head daily plane service supplies the camps with men, equipment and subsistence. The pioneer railroad project is scheduled to begin delivering ore in 1954.

Titanium Metal Plant Commences Operation

First production of titanium metal at the newly constructed Henderson, Nev., plant of the Titanium Metals Corporation of America is announced. The company, owned jointly by the National Lead Company and the Allegheny Ludlum Steel Corporation, will expand output until an initial production goal of ten tons a day is reached late next year. This output will be equivalent to eight times the present world production of titanium metal.

The Henderson project was announced on August 6, following the signing of a letter of intent by the General Services Administration in response to urgent demands for the metal from both military and atomic energy agencies. The H. K. Ferguson Co., industrial engineers and builders of Cleveland, Ohio, has the contract for engineering and constructing the $14,000,000 plant, which is utilizing the site and many of the facilities of a wartime magnesium plant built by the government and operated by Basic Magnesium, Inc. A minimum amount of new construction will be required.

Contract Let for Virginia Sewage Treatment Plant

Construction of a sewage-treatment plant for Arlington County, Virginia, will get under way following recent award of a $2,874,810 contract to the Thompson-Starrett Co., of New York. About 18 months will be required for completion of the project, which is part of an over-all program for eliminating pollution in the Potomac area. The plant was designed by Alexander Potter Associates, New York City consultants.

Navy Continues Major Construction Program

Improvement of existing Naval hospital facilities and construction of new facilities constitute an important part of the Navy's expansion program. The former Naval hospital at Corona, Calif., the San Leandro section of the Oakland Hospital, and the hospital at the Bainbridge, Md., Naval Training Station have recently been reactivated by the Civil Engineering Corps at a cost of about $4,800,000. Major new hospital construction completed during the year was a $15,000,000 hospital at St. Albans, N.Y. Facilities at the latter hospital include a laboratory especially designed to permit work with radioactive materials. Construction of a new $18,000,000 hospital on the Island of Guam has been started.

The release of $7,302,765, the last increment of funds needed to complete the $30,000,000 island-wide utility system for Guam is also announced by the Navy Civil Engineer Corps. These funds will cover the cost of building the final links in the water, telephone, power, and sewerage systems started in 1947. The Brown Pacific-Maxon Co., which has been building the Guam facilities, has been authorized to begin work on a network of sewers, the last of five reservoirs, and the second of two telephone exchanges.

Bids will soon be opened by the Civil Engineers Corps for five major projects which are part of the $10,000,000 expansion program for the Naval Auxiliary Air Station at Miramar, Calif. Jobs will include construction of a water-distribution system for the field, a central heating plant, and standby power plant. Miramar, which is being expanded into a master jet field, already has a new runway under construction. Other contracts will soon be awarded for additional bulk storage facilities costing about $4,000,000. Another pending project is a $20,000,000 East Coast supply center for the Marine Corps near Albany, Ga. The first increment of construction will include area grading, general site drainage, and water and sewer lines.

Army Camp Rehabilitation Program Nears Completion

The Army Corps of Engineers has completed 90 percent of the 1951 program to rehabilitate Army posts, camps, and stations, according to an announcement from Lt. Gen. Lewis A. Pick, Chief of Engineers. Housing and training facilities for more than 675,000 officers and men are now ready for occupancy. The complete rehabilitation program, which is scheduled for completion early in 1952 at a cost of $113,000,000, will provide troop facilities for 745,000 men.

A major portion of the work consisted of repairs to permanent and temporary buildings, and restoration of the electric, water, sewage, heating, refrigeration, and fire-protection systems to operating condition.

DPA Adopts Construction Conservation Program

A program to aid in conserving scarce materials used in building construction and thusallow for more construction in 1952 with the materials available has been devised by the Conservation Coordinating Committee of the Defense Production Administration, according to an announcement from the DPA. The program is based on standard design practices recommended by the Facilities and Construction Bureau of the National Production Authority for use by architects and engineers in the construction industry.

"The fact that even projects which are directly a part of the defense mobilization program will have to wait for steel suggests that each builder or designer, before making final plans for construction, should seriously consider how quickly he wants to go ahead," the DPA notes. It is expected that eventually more steel will be available for other than military uses. In the meantime, the DPA suggests that builders wishing to minimize delay should make use of the recommended construction conservation practices.

The following recommendations are included in the DPA memorandum:

"1. Structural and reinforcing steel may be conserved in many one-, two- or even three-story buildings by using wall-bearing masonry construction in lieu of structural steel frame or reinforced concrete frame.

"2. For many types of structures, savings of approximately 50 percent in steel content may be made when reinforced concrete replaces structural steel, and even greater savings are possible when timber is used instead of structural steel or reinforced concrete.

"3. Many steel-conservation measures are available in reinforced concrete construction, including flat-slab construction instead of beam and girder, pan or masonry filler types, and the use of square or rectangular columns with ties instead of smaller columns with spirals.

"4. In many instances fireproofing of adequate resistance may be obtained by specific use of non-critical materials.

"5. For many uses lightweight concrete and plaster aggregates may be successfully used to replace heavier aggregates, and thus lower quantities of structural or reinforcing steel needed for load-carrying members and foundations.

"6. Alloys for the manufacture of low-alloy, high-alloy and stainless steels are generally in extremely short supply. Therefore alloy steels should not be specified in building construction where suitable substitutes are available. Enameled, plated and even stainless clad carbon steels conserve alloys when used in lieu of stainless steel.

The NPA also identified seven design standards as "good practice, considered acceptable to most engineers, architects, building officials and municipalities," and recommended their use in conserving scarce materials. These are:

For structural steel, "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," of the American Institute of Steel Construction; for reinforced concrete, "Building Code Requirements for Reinforced Concrete" of the American Concrete Institute; and for lumber, "National Design Specifications for Stress-Grade Lumber and Its Fastenings," of the National Lumber Manufacturers Association.

New York Office Building Employs Lightweight Aggregate

LIGHTWEIGHT construction characterizes 260 Madison Avenue Corporation's 21-story office building under construction in midtown Manhattan by Hegeman-Harris Co., Inc., on fixed-fee contract of about $12,000,000. Lightweight aggregate—Waylite, an expanded blast-furnace slag—is being used for floor concrete. Pipe scaffolding for brick hoist on Madison Avenue front rises full height of building. Sylvan Bien is architect and Weinberger & Weishoff, structural engineers.

Chamber of Commerce Urges Building Code Standardization

The urgent need for standardization and simplification of the more than 2,000 building codes in the country is cited in a recent report of the Chamber of Commerce of the United States, entitled *Building Codes and Construction Progress*. In particular, it notes the "necessity for early modernization of codes in view of rearmament demands requiring the most effective use of materials in defense construction." The statement is based on a report by a special committee of construction experts appointed by the Construction and Civic Development Department of the Chamber to study the situation.

Business, construction, and other interested local groups are urged to take active responsibility for obtaining modernization and sound administration of codes. The report also recommends uniform state legislation that would require communities to keep their codes up to date and authorize less complicated means of adoption of standard codes and requirements.

"Any one of four standard codes prepared by as many competent organizations and now beginning to meet increasing acceptance" are recommended for adoption. There is no reason, according to the report, why standards meeting safety and other requirements in one city should not be generally acceptable elsewhere.

In urging model legislation by all states to facilitate the standardization of codes, the Chamber declares that the states should require that municipal building codes permit the use of any materials or method of construction that meet minimum standards of performance. "Codes," it states, "should be acceptable if they permit the use of methods and materials which comply with recognized standards or requirements developed through acceptable industrial processes and by qualified agencies.

Copies of the report may be obtained from the Chamber of Commerce of the United States, Washington 6, D.C., at 50 cents each, and at 30 cents each in lots of ten or more.

United States and India Sign Reclamation Agreement

Under the terms of a formal agreement between the governments of the United States and India, signed recently at New Delhi by representatives of the two nations, the Bureau of Reclamation will furnish advice and scientific and technical engineering service in the United States to the Indian Government. The agreement, completed with the aid of the Department of State, provides for direct communication between the Commissioner of Reclamation and the Central Waterpower, Irrigation and Navigation Commission in the handling of technical engineering matters.

The personnel and laboratory facilities of the Bureau at its Denver Engineering Center will be made available to assist the Indian government with water-development problems. The agreement stipulates that such services will be undertaken only when they do not conflict with the Bureau's domestic conservation program; that the Indian government will pay all costs; and that no work will be done outside the United States.

Tests conducted by the Bureau for the Indian government early this year have resulted in a saving of $10,000,000 in the cost of the 785-ft Kosi Dam in the southeastern corner of Nepal, which will be the highest dam in the world.

Congress Votes $597,000,000 for Floods and Navigation

A bill appropriating $597,262,713 for the civil functions of the Army Engineers was passed by Congress in its closing days. The appropriation includes $192,657,613 for river and harbor projects; $316,544,100 for flood control; $60,500,000 for the lower Mississippi; and $11,595,000 for the Panama Canal. In its final form the bill represented a compromise on the part of both branches of Congress—a $41,315,500 cut from the bill as passed by the Senate last August and an $81,835,313 increase over the bill passed by the House last June.

In another action, the Senate passed and sent to the White House a bill providing for $114,690,000 in funds and authorizations for emergency relief in flood-stricken areas of Kansas, Missouri, Oklahoma, and other Midwestern states.

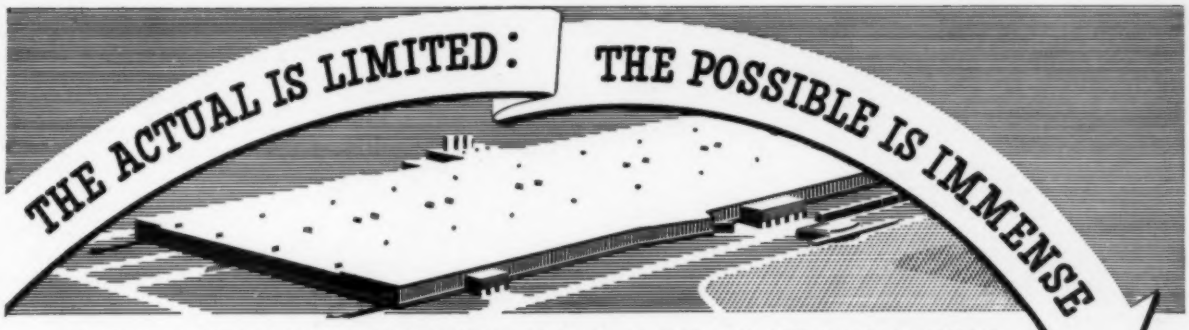
Center Opened for Snow, Ice and Frost Research

To improve American military operations in extremely cold climates, the Department of the Army is establishing a Snow, Ice and Permafrost Research Headquarters at Wilmette, Ill., according to an announcement from Maj. Gen. Lewis A. Pick, M. ASCE, Army Chief of Engineers. Fundamental physical and mechanical properties of snow, ice and permafrost will be studied to facilitate movement of troops and equipment and construction methods and techniques in Arctic and Antarctic regions.

Lt. Col. A. H. Lahlum will be in command of the new research center.

At Construction Site of New Hudson River Pier

CONCRETE BOX SUBSTRUCTURE for large Hudson River pier, designed to replace Pier 57 on Manhattan waterfront which burned in 1947, is being built in pumped-out lake bed along Hudson River near Grassy Point, N.Y. Separated from the Hudson by a thin embankment, the lake was pumped dry this spring and its bed leveled and coated with gravel in preparation for the substructure work. The substructure consists of three giant reinforced concrete boxes weighing 27,000 tons each, which are being built atop thick concrete mats that will serve as the bottom form for their heavy base slabs of reinforced concrete. When the pontoon-type boxes are completed next spring, the lake bed will be flooded again and the boxes floated 35 miles down the Hudson and into position at West 15 Street. Merritt-Chapman & Scott and the Corbetta Construction Company, joint construction companies on the project, hold $5,685,491 low-bid contract for substructure and deck. Project was objective of ASCE Waterways Division inspection trip during recent Annual Convention.



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

WELDED DESIGN SAVES $30,000 ON MULTI-STORY FRAMEWORK

By Van Rensselaer P. Saxe
Engineer
Baltimore, Maryland

IN the recent construction of the 14-story Broadview Apartment in Baltimore, Maryland, welded design saved an estimated $30,000 over what the structure would have cost with riveted construction. By utilizing steel more efficiently, as made possible by welding, and eliminating butt plates and angles, steel requirements for the multiple story framework were cut from 2045 tons to 1960 tons . . . a net saving of 85 tons.

Designed as a rigid frame, beams, columns and girders were shop fabricated at low cost with fast, downhand welding techniques.

Field welds were so engineered as to permit field splices to be welded in downhand positions on most joints.

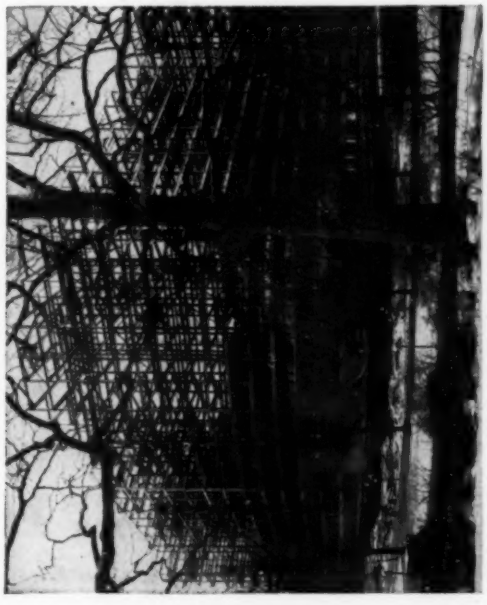


Fig. 3—1960 ton welded steel rigid framework for the 14-story Broadview Apartment, Baltimore, Maryland. Fabricators and Erectors: The Vulcan Rail and Construction Company, Baltimore, Maryland. Architects: Palmer, Fisher, Williams and Nes, Baltimore, Maryland.

WELDED DESIGN ALWAYS SAVES STEEL AND CUTS COST

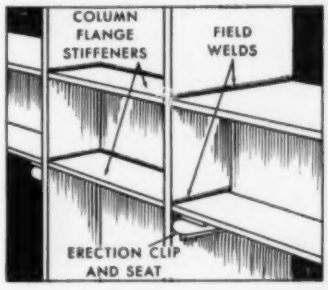


Fig. 1—Typical Beam-to-Column connection, simplified by welding, eliminates costly angles to speed erection.

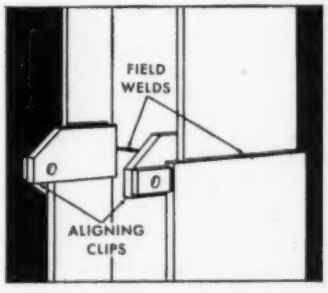


Fig. 2—Column Splice designed to facilitate simple field welding in downhand position.

HERE IS PROOF

Studies in Structural Arc Welding are available to Engineers and Designers. Write on your letterhead to Dept. 144,

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO

Vertical Parking Featured in Virginia Shopping Center

LARGE PARKING BUILDING—a five-story steel and concrete structure with capacity for 2,000 cars—is key to $13,000,000 landscaped shopping center that will be opened in Arlington, Va., in November by the Hecht Co. Located at intersection of two important highways, center will have total parking facilities for 10,000 cars and is designed to bring maximum pedestrian and motor traffic to the 30 stores included in the project. Location of the parking building in the center of the 15-acre development puts all stores equidistant from the motorist. Angle parking, equivalent to 15 acres of surface parking, will be used on all floors of the $3,000,000 parking structure, which is 570 ft long, 256 ft wide, and 40 ft high. Parking will be free for first two hours and 25 cents per hr thereafter. Abbott, Markt & Co., New York City, are designers; Kahn & Jacobs, New York City, associate architects; and Edward A. Ashley, New York City, associate engineers for mechanical, electrical, and air conditioning design. General contractors are the Prescott Construction Co., of Washington.

Alaska District Engineer Lets Construction Contracts

A number of new Alaska construction contracts have been let by the Corps of Engineers, according to an announcement from Col. L. E. Seeman, Alaska District Engineer. These include award of two Whittier contracts to the Seattle firm of Haddock Engineers, Ltd., and Associates, which won the central power and heating plant award on a bid of $4,118,252, and the award for outside utilities on a bid of $1,678,500. L. E. Baldwin, of Seattle, received a contract for the construction of barracks at Elmendorf Air Force Base with a low bid of $3,481,400, and Morrison Knudsen, of Seattle, an award for construction of bulk petroleum storage and handling facilities at Eielson Air Force Base for a total bid of $2,505,500.

Michigan Engineering Group Studies Building Code Status

Results of a recent survey conducted by the Building Code Committee of the Michigan Society of Professional Engineers on the status of building codes in Michigan cities having a population of 6,000 or more are reported in a tabulation just issued by the society.

The tabulation shows that 23 percent of the 82 cities surveyed have no code at all, and that 27 percent of the remaining cities have codes that have not been revised within the past ten years. With very few exceptions, all municipalities surveyed which have either no code or an old code, are now considering adoption of a new code or revision of the existing code. The tabulation also indicates that, of the three nationally recommended codes which have been adopted by the surveyed communities to date, the Pacific Coast Code is predominant. However in the communities considering new or revised codes, the drift of choice is decidedly toward the new Building Officials Conference of American Codes, which was first published in the late summer of 1950.

Inquiries concerning the survey may be addressed to the Building Code Committee of the Michigan Society of Professional Engineers, 100 Farnsworth Avenue, Detroit 2, Mich.

General Motors Dedicates New Engineering Center

Recent opening of three engineering staff buildings at the new General Motors Technical Center near Detroit marks the first major step in a project aimed at regrouping of GM technical, research, and styling facilities. Under construction since July 1949, the center occupies an 813-acre tract just north of the city. With completion of the Engineering Group, consisting of administration and drafting, shop, and dynamometer buildings and involving a total of 235,000 sq ft of office and shop space, the entire project is from 35 to 40 percent completed. Eventually the area will contain the GM Research Laboratories Division, the Process Development Section, the Styling Section, and a Service Center. The buildings will be grouped around a 22-acre lake that will have a utility value in connection with operation of the center.

The functionally modern buildings in the Engineering Group were designed by Saarinen-Saarinen and Associates, of Bloomfield Hills, Mich. Architect-engineers on the project are Smith, Hinchman & Grylls, Inc., of Detroit, and the general contractor is Bryant & Detwiler Company, of Detroit.

Serious Drought in Southern California Continues

Streamflow in Southern California during the year ending September 30, 1951, was the lowest in the past four years, according to a review of water supply conditions just completed by the Geological Survey. Runoff in eight selected streams averaged only 8 percent of normal, and Lake Elsinore in the Santa Ana Mountains is reported dry for the first time.

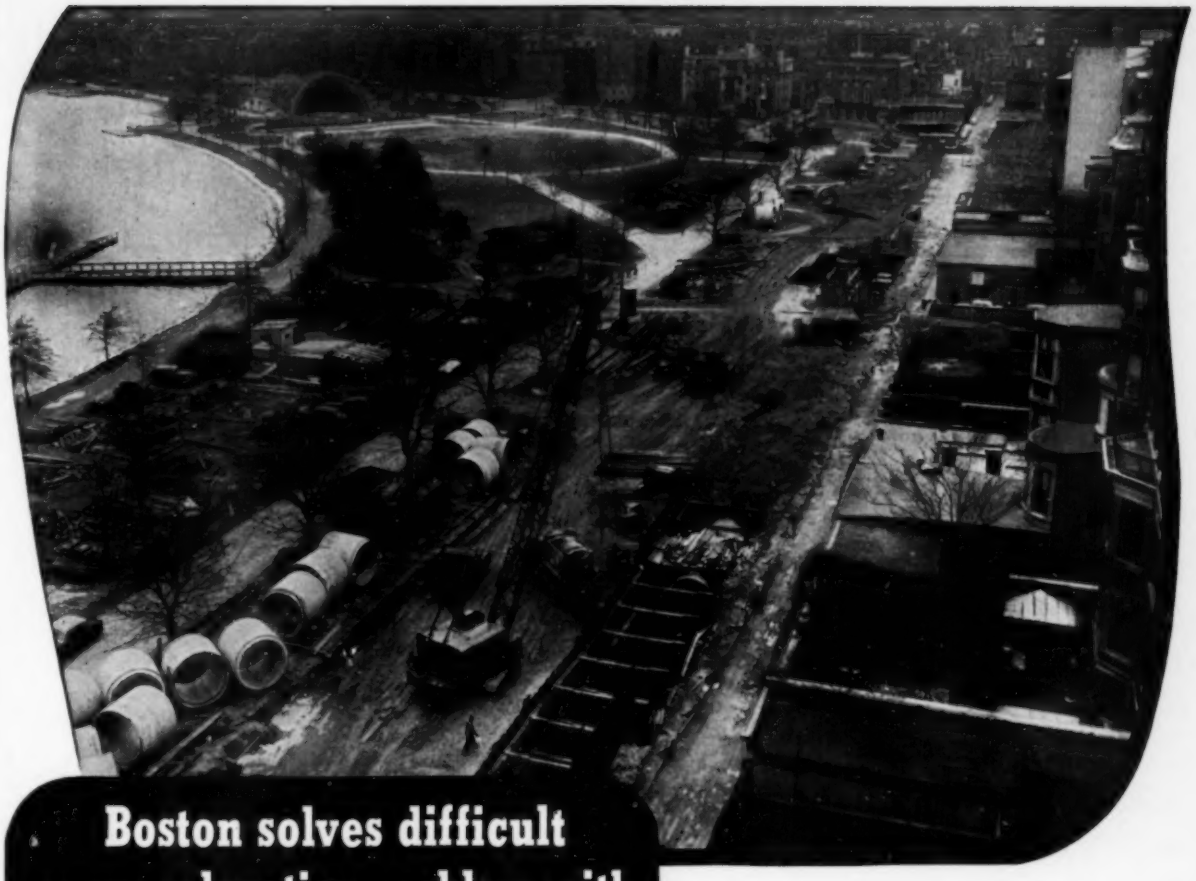
Rainfall records collected at Los Angeles during the past 74 years indicate three dry periods: The first, 1893–1908; the second, 1918–1933; and the third, beginning in 1936, is continuing unabated. Though the present dry period has not so far equaled the first or second in severity, the Survey notes, it may yet prove to be the worst of the three.

The current drought is rendered relatively more critical than previous droughts because of the greatly increased use of water, according to the Survey. Reservoirs built in the mountain areas to store surplus water during wet years are now substantially empty, except for those containing imported water. Declining groundwater supplies over much of the area add to the seriousness of the situation.

Urban Growth Is Studied in Defense Plant Areas

To help solve housing and other community development problems resulting from the rapid influx of population to new defense production centers, the Housing and Home Finance Agency is sponsoring two-year research projects that will measure effects of two great new defense plants on their surrounding areas.

Under one of these projects, the University of North Carolina will study urban growth around the new plant of the Atomic Energy Commission on the Savannah River in South Carolina. The University of Pennsylvania will conduct a similar study for the Agency on urban development around the United States Steel Company's works now being built at Morrisville, Pa. The findings will be utilized first in the areas studied as an aid to assuring adequate living conditions.



Boston solves difficult sewer relocation problem with CONCRETE PIPE

To make way for a vehicular tunnel on the new four-lane James J. Storrow Memorial Embankment Expressway along the Charles River in the Back Bay section of Boston it was necessary to relocate an 8-ft. diameter marginal conduit.

Because of its many qualities, reinforced concrete pipe was chosen for the new sewer. In all, 2040 ft. of 96-in. straight pipe and 225 ft. of 96-in. radius pipe was used, manufactured in 8-ft. lengths (ASTM specification C76-41, Table 1).

The subsoil in the area was so soft it was deemed necessary by the Metropolitan District Commission engineers to build a special support for the pipe by driving piles into the subsoil and adding a bed of gravel covered with a concrete mat. This uniform support at the base of the pipe increased the load the pipe can carry.

This is another example of how concrete pipe can be used to solve difficult or unusual sewer problems. In thousands of installations over scores of years concrete pipe has demonstrated its rugged durability, great structural strength, maximum hydraulic capacity, minimum infiltration and leakage, resistance to wear by abrasive matter.

Concrete pipe is moderate in first cost, requires little or no maintenance and serves longer. The result is real *low-annual-cost* sewer service.

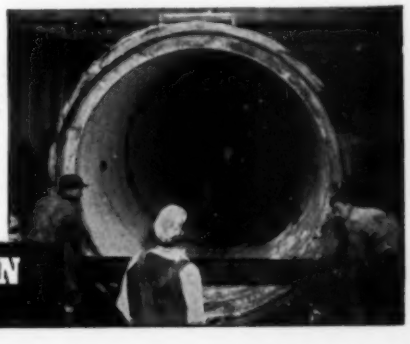


Photo at right shows 8-ft. concrete pipe being lowered and placed in open cut. Note use of sheeting on walls of trench to prevent cave-in of the soft subsoil.

AMERICAN CONCRETE PIPE ASSOCIATION
228 NORTH LA SALLE STREET, CHICAGO 1, ILLINOIS

Brazos River Project Receives Planning Funds

Five projects constituting another step in the master plan of the Brazos River (Texas) Conservation and Reclamation District have been approved to receive $307,500 in interest-free advance-planning funds by the Housing and Home Finance Agency.

The planning funds will be used to assist the District in the preparation of engineering studies, surveys, drawings and plans for construction of (1) A dam and powerhouse in the Bee Mountain project, covering watershed areas in Johnson, Bosque, and Somerville counties; (2) hydroelectric power facilities, comprising the Hightower project, about 30 miles southwest of Fort Worth; (3) a dam and powerhouse at South Bend in Young County; (4) a dam and powerhouse near Breckenridge; and (5) power-generating units in Palo Pinto and Hood counties. Except during abnormal floods these works, together with existing projects, will regulate the flow of the Upper Brazos furnishing electric energy and municipal water supplies as well as water for industrial and irrigation purposes.

The Ambursen Engineering Corp., of New York and Houston, is engineer for the District.

ASA Subcommittee to Study Hydraulic Letter Symbols

Recent reconstitution of the American Standards Association Subcommittee Y10.2 on Letter Symbols for Hydraulics, for the purpose of reviewing and revising the 1942 Standards on Letter Symbols for Hydraulics, is announced by the ASA. The committee will appreciate receiving comments from interested persons on the 1942 Standards and suggested additions to or modifications of the Standards. It has been tentatively decided to consider the field of hydraulics as being concerned with all phases of the motion of fluids, and an attempt will be made to include symbols in the field of hydrology and water hammer.

Suggestions and comments should be directed to Dr. J. M. Robertson, Chairman, ASA Subcommittee Y10.2, P.O. Box 30, State College, Pa.

Aluminum Production Rises Until Power Shortages Hit

The primary aluminum industry in the country continued its production rise during August, although power shortages in the Pacific Northwest have since forced curtailment, according to the Aluminum Association, which represents all primary producers of the metal and about 85 per cent of all semi-fabricated aluminum products in the country.

Primary output for August reached the high level of 147,630,992 lb, exceeding the July figure of 145,395,271 lb by more than 2,000,000 lb. July and August increases are attributed to "expansion and reactivation programs within the industry, which eventually will increase its annual capacity by more than a billion pounds."

Private Homebuilding Gains in September

Homebuilders started 91,000 new permanent non-farm dwelling units in September, an increase of 7 percent over August, according to preliminary estimates of the U.S. Labor Department's Bureau of Labor Statistics. This increase is attributed partly to the September 1 easing of credit limitations, and partly to builders' efforts to get construction projects under way before further materials controls are imposed.

Housing activity for the first nine months of 1951 totaled 852,000 new dwelling units, well above the 1948 and 1949 levels, but 23 percent under the record attained in the same period of 1950. Private builders' housing volume during the third quarter of 1951 was down only 8 percent from the second quarter, despite virtual disappearance of pre-Regulation X commitments.

Most sections of the country are said to be sharing in the housing increase. Cities reporting major increases during the month were Houston, Indianapolis, Memphis, Miami, Pasadena, Shreveport, and St. Louis.

Neare's N. G. COLUMN

R. Robinson Rowe, M. ASCE

"Professor Neare," said Joe Kerr, "I have a problem."

"If it's good, let's hear it."

"Oh, it's good all right, in fact, too good to be true. A doe in the southeast corner of a square 10-acre field spied two hounds in in the northeast and northwest corners and started running west along the fence just as the hounds spied the doe and . . ."

"Hold on, Joe, that's Guest Professor Sauer Doe's problem that we were just going to talk about, except that he had the hounds pursuing a hare."

"That wasn't a fair problem—two hounds chasing one poor little scared rabbit. So I took him out and put in a doe, the Guest Professor himself. Let's see how he likes it!"

"I'll like it," hedged Guest Professor Doe, "if you know all the answers. If both hounds caught me at the same time, where would I be? How much faster must I run to escape at the southwest corner?"

"I still don't know," admitted Joe. "In a book I found an equation for the dog's path; it looked like a skewed catenary. Don't ask me to intersect two of those."

"He didn't have to," snorted Cal Klater. "There's a handy intrinsic property of the general pursuit curve: it's length from any point to the kill equals the dog-leg distance via the instantaneous mid-point between pursuer and pursued. Hence if x is the distance from southeast corner to the kill:

$$330 + \sqrt{x^2 + 330^2} = 330\sqrt{2} + \sqrt{330^2 + (330 - x)^2}$$

The solution is $x = 330$, so the hare was caught halfway to his hole and each hound ran $330(1 + \sqrt{2})$ ft."

"Why how *easy*!" shouted Joe. "Now even I can finish it. For a hare's-breadth escape at the southwest corner, Bugler's dog-leg is $330(1 + \sqrt{5})$ and Caesar's only $330(\sqrt{2} + \sqrt{2})$, so Caesar is the hound to beat. Aaron, the hare, or Sauer, the doe, must speed up in the ratio of $1 + \sqrt{2}$ to $\sqrt{2}$, or run 70.71 per cent faster for a dead heat. For a safe get-away, give him an extra grunt."

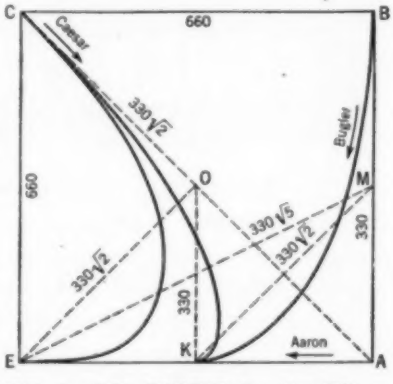


FIG. 1. CAL TAUGHT Joe that BK = BM + MK

"Well, Joe, after that lesson from Cal you made up for lost time. Noah, did I hear you say that the next lesson involved circular pursuit?"

"Soon, but not next, Sauer," promised Professor Neare. "More urgent is a letter I just received from Flo Ridan asking if I could make 'something' of his complete list of triangles having integral sides and area equal to perimeter. So here's the 'something.'

"A father left a quadrilateral tract to his four minor sons, to be divided in proportion to their ages at their last birthdays. By coincidence it could be done by cutting along

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the two diagonals. By a further coincidence, the triangular lots of each of the three younger sons were in Flo's list. How old was the eldest son?"

[Cal Klaters were: Richard Jenney, Elihu Geer, Stoop (John L.) Nagle, Donald (DonT) Thayer, Flo Ridan (Charles G. Edson), W. P. Linton, A. Nuther Nutt (anon.), C. W. Trigg, and Injun Ear (Hamilton Gray). Guest Professor Sauer Doe was Marvin A. Larson. Also received were solutions to August's demiluna pool problem from vacationers Thatchrite (Guy C. Thatcher), X. L. A. Bridger (Ralph Stewart) and Wm. C. Hunter.]

DECEASED

Herbert Miller Hale (M. '17) retired construction engineer of Orient, N.Y., died there on September 1. He was 69. After graduating from Harvard Engineering School in 1904, Mr. Hale entered the employ of the New York Board of Water Supply. He later became associated with the contracting firm of Spencer, White & Prentis, Inc., and was managing engineer in charge of construction of a section of the Sixth Avenue Subway and the foundation for the new Criminal Courts Building. During World War II he was in charge of construction of the Bayonne, N.J., Dry Dock. He was a past-president of the Harvard Engineering Society.

Charles Haydock (M. '25) consulting engineer of Philadelphia, Pa., died there on August 31, at the age of 63. From 1905 to 1907 Mr. Haydock was engineer assistant and inspector for Franklin & Clarke. He then served successively as assistant engineer, principal assistant engineer, and engineer for the Pennsylvania Railroad Water Supply Systems, and later was consulting engineer to many municipalities and utilities on water supply problems. He was educated at the University of Pennsylvania. Mr. Haydock served on a number of Philadelphia Section committees and was Section director for two years.

Andrew Pearson Hoover (M. '17) retired consultant of Pleasantville, N.Y., died on September 16. His age was 72. During his career Mr. Hoover served as engineer for the Charles T. Main Construction Co., in Boston, Mass.; engineer and assistant vice-president for the John W. Ferguson Co.; and was a founder of the New York consulting firm of Goodrich & Hoover. Later he was consulting engineer to the American Sugar Refining Co., vice-president and director of the Holbrook, Cabot & Rollins Corp., construction engineers of New York and Boston, and from 1930 to 1940 was an engineering consultant in New York. He graduated from Roanoke College and attended Rensselaer Polytechnic Institute.

Guy Howard Humphreys (M. '42) for the past ten years senior partner in the civil engineering firm of Howard Humphreys & Sons, of London, England, died on August 20. He was 55. Upon his graduation from Cambridge University in 1915, Mr. Humphreys became maintenance engineer at the H. M. Factory, Oldbury, England. He subsequently worked as assistant to the late H. Howard Humphreys on the design of a railway for the British Dyestuffs Corp., Ltd.; resident engineer on construction of the railway at Manchester; and resident engineer on the reconstruction of the Norfolk Bridge over the River Adur. He had been a member of the firm of Howard Humphreys & Sons since 1925.

Charles Eugene Johnston (M. '12) of LaJolla, Calif., died on July 10, at the age of 69. Mr. Johnston did railroad engineering work in central Illinois from 1897 to 1903. Later he was division engineer for the Missouri Pacific on the construction of the White River Line from Carthage, Mo., to Newport, Ark., and assistant engineer for the S.L. & S.F. Railroad. For 30 years he was with the Kansas City Southern Railway as chief engineer, general manager, vice-president, and president.

Edward James Mershon (Assoc. M. '21) contracting engineer for the Pittsburgh-Des Moines Steel Co., at Neville Island, Pa., died on September 25. His age was 58. Associated with the Pittsburgh–Des Moines Steel Co. from 1916 to his death—except for a period of service in the Navy Air Force during World War I—Mr. Mershon worked as contracting engineer particularly concerned with the design and sales of elevated steel tanks. Earlier he was employed by the State of New York and the New York State Highway Department. He received his education at Cornell University.

Harry Fancher Miter (M. '30) vice-president and manager for the Austin Co., at Cleveland, Ohio, died on October 5. He was 73. Mr. Miter first worked for the Chicago & Northwestern and the Pennsylvania railroads, the King Bridge Co., and the Watson Engineering Co. In 1918 he joined the Austin Co., which he had served as vice-president since 1930 and as district manager of the Cleveland District since 1934. He graduated from Rensselaer Polytechnic Institute.

Samuel Jacob Ott (M. '14) retired civil engineer of Rutherford, N.J., died on August 17, at the age of 72. In 1901 he graduated from Delaware College and shortly thereafter began work at the Edge Moor Plant of the American Bridge Co. Mr. Ott was transferred to the New York office of the American Bridge Co. in 1904, becoming engineer in charge of bridge estimating and design in 1913 and division engineer in 1936. He held the latter position until his retirement in 1945. He also served the Canadian Pacific Railway and the U.S. Steel Products Co. in Buenos Aires and Montevideo.

Rowland Cuthbert Robin (M. '51) since 1939 professor of civil engineering at the University of Adelaide, Adelaide, Australia, died on July 30. He was 52. From 1930 to 1938 Professor Robin was lecturer in civil engineering at the University of Adelaide, having charge of all teaching in hydraulics and surveying. Earlier he had been designing engineer in the engineering and water supply department of South Australia; assistant engineer for the Kidman Contracting Co., at Adelaide; and junior engineer for Kirk & Randall, Ltd., at Manchester, England. He was educated at the University of Adelaide.

Robert Stuart Royer (M. '32) head of the firm of R. Stuart Royer & Associates, of Richmond, Va., died on September 21, at the age of 67. At the outset of his career Mr. Royer was affiliated with the N. & W. and Virginia railways, and later was consulting engineer for Roanoke, city manager for Fredericksburg, and business manager of the Chamber of Commerce, at Alexandria. Subsequently, he became general manager for the contracting firm of Rogers & Royer, president of the Royer-Ferguson Co., partner in the Baker-Royer Co., and in 1928 president of the firm bearing his name. Long active in the Virginia Section of the Society he served a term as president. He was a Virginia Polytechnic Institute graduate.

Walter Adam Shaw (M. '16) of Wilmette, Ill., died on September 3. His age was 84. Early in his career Mr. Shaw served as engineer for Chicago, Ill.; member of the firm of Alexander & Shaw; and chief engineer for Chicago in charge of the sewer division and water works. He had also been connected with various water and utility commissions in Illinois, Michigan, and New Jersey, and was president of the American Engineering Construction Co. In private consulting work for approximately 30 years, Mr. Shaw was engaged more recently by the Chicago Rapid Transit Co. and the Chicago Surface Lines. He graduated from Valparaiso College.

Clinton Brown Stewart (Assoc. M. '98) retired consulting hydraulic engineer of Anchor, Ill., died on September 2, at the age of 83. During his career Mr. Stewart had been professor of civil engineering at Colorado State School of Mines, U.S. Assistant Engineer, and researcher in hydraulic engineering at the University of Wisconsin. For many years he practiced engineering in Madison, Wis. He was the author of numerous technical articles on hydraulic engineering subjects. He received his training at Cornell University.

William James Whitehead (Assoc. M. '41) lieutenant colonel, Corps of Engineers, Department of the Army, in the Office of the Chief of Engineers, at St. Louis, Mo., died on September 17. He was 43 and a graduate of the Case School of Applied Science. At the beginning of his career Mr. Whitehead served the Cuyahoga County (Ohio) Sanitary Engineering Department, the Cleveland Union Terminal Co., and the Cleveland Railway Co. Later he was civil engineer for the Cleveland Water Department and resident district deputy engineer for the Ohio State Department of Highways at Ironton. In 1939 he became assistant civil engineer in the office of the Quartermaster General, Washington, D.C.

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NEWS OF ENGINEERS

Herbert Hoover, Honorary Member of ASCE, has been awarded the Howard Coonley Medal of the American Standards Association for "long and outstanding service in advancing the national economy through voluntary standards." The presentation was made at the closing session of the three-day Standardization Conference held in New York on October 24.

Roman C. Berzowski, until recently estimator for the Tri-State Construction Co., at Memphis, Tenn., has been recalled to active duty as assistant resident officer in charge of construction at the U.S. Naval Air Station in Memphis. Lieutenant Berzowski will supervise the construction of the new runway and the taxiway and act as inspector for the Navy on a $3,500,000 housing project.

R. E. Bakenhus, rear admiral (CEC) USN (retired) and consulting engineer of New York City, was Society representative to the World Engineering Congress held recently in London. He discussed drydocks at one of the technical sessions.

Philip H. Carlin, formerly with Smith, Hinchman & Grylls, Inc., of Detroit, Mich., is now chief of the specifications department for Harley, Ellington & Day, Inc., of the same city.

Ellsworth I. Davis, for the past two years district engineer of the Galveston (Tex.) District of the Corps of Engineers, has been assigned to the Far East Command, in Yokohama, Japan. Colonel Davis has been directing a large program of rehabilitation and new construction at Army and Air Force installations in southern Texas and Louisiana.

Carl E. Arnold has recently retired as county engineer and surveyor of Los Angeles County, California. Mr. Arnold has been employed as construction engineer, chief deputy, and since 1924 county engineer and surveyor of Los Angeles County. He has also been a member of the Regional Water Pollution Control Board in California. He is past-president of the City and County Engineers Association of Los Angeles.

C. E. Arnold

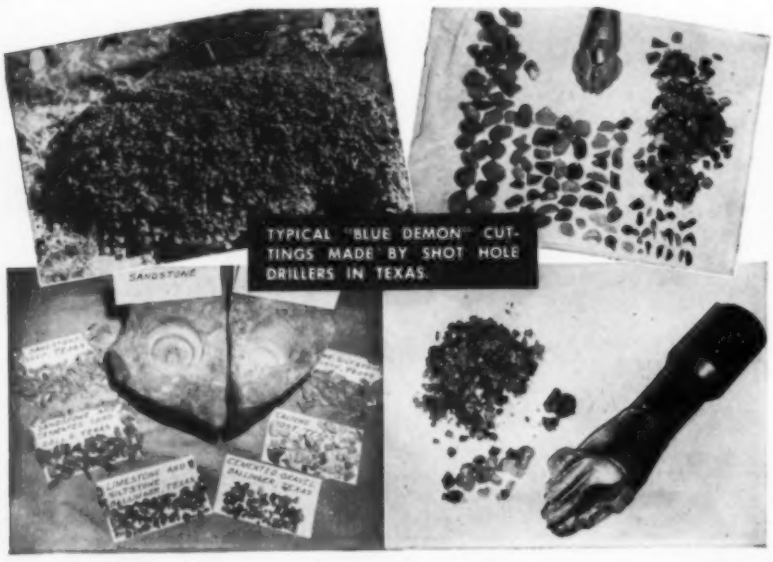
Henry T. Heald, president of Illinois Institute of Technology in Chicago, has been named chancellor of New York University, succeeding **Dr. Harry Woodburn Chase,** who has retired after 18 years of service. Dr. Heald will assume his new responsibilities early next year. He joined the Armour Research Institute of Technology in 1927, becoming president in 1938. When Armour Institute was combined with Lewis Institute in Chicago in 1940 to form the Illinois Institute of Technology, he was named president. In addition Dr. Heald is president of Armour Research Foundation and heads the Institute of Gas Technology in Chicago.

Henry T. Heald

N. D. Morgan, Jr., previously on the faculty of the University of Wyoming, has been recalled by the Corps of Engineers. Major Morgan has been assigned to the Army ROTC Unit (Corps of Engineers Branch) at the University of Detroit, where he will serve as assistant in charge of plans and training and adjutant of the unit.

Leslie E. Colby announces the opening of new offices of the Colby Construction Corp., at 1304 North LaSalle Street, Chicago, Ill. He has been engaged on the construction of modern residences in Skokie, Ill.

(*Continued on page 78*)



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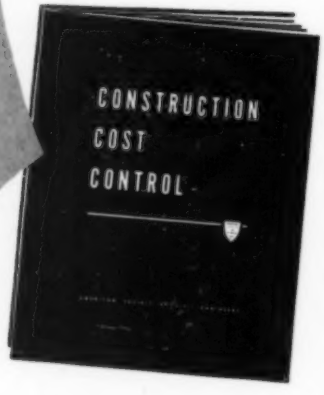

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News of Engineers

(*Continued from page 76*)

Alfred J. Ryan, Denver, Colo., consultant, announces the formation of an organization to be known as A. J. Ryan & Associates, Engineers, with offices at 1340 Glenarm Place, Denver. The firm will provide complete services in the fields of civil, electrical, mechanical, and structural engineering.

Charles W. Thomas

Charles Walter Thomas, head of the hydraulic investigations group at the U.S. Bureau of Reclamation laboratories in Denver, Colo., has gone to France to begin a year of advanced research at the University of Grenoble, working toward a doctoral degree in hydraulic engineering under provisions of the Fulbright Educational Exchange Act. He expects to be assigned to the Laboratorie Dauphinois D'Hydraulique (Ets Neyrpic) at Grenoble.

John W. Foster is now on hydroelectric construction work with the Aluminum Company of Canada, Limited, of Montreal, Quebec. For the past three years he has been hydraulic engineer in the planning section of the Hydroelectric Construction Department, Companhia Brasileira Administradora de Servicos Tecnicos, Sao Paulo, Brazil. Mr. Foster is co-winner of the Collingwood Prize for Juniors this year.

Robert B. Brooks, consulting engineer of St. Louis, Mo., was engineer-representative of the Department of State at the Fifth Pan-American Highway Conference held in Lima, Peru, in October. Mr. Brooks recently completed a term as ASCE Vice-President.

Andre L. Jorissen, who has been in charge of the Hydraulics Laboratory at Pennsylvania State College for the past two years, has been named head of the hydraulics department in the school of civil engineering at Cornell University.

A. V. Lynn, formerly engineer of design for the California Water Service Co., with headquarters at San Jose, has been appointed chief engineer there. The California Water Service Co. operates the water supply systems of 30 cities in the state.

Clarence C. Davis, since 1950 resident engineer for the Corps of Engineers, at Detroit Dam, Portland, Oreg., has been named resident engineer at Lookout Point Dam, under construction on the Middle Fork Willamette River. Colonel Davis succeeds Robert E. Lee, who has become chief of the supervision and inspection branch of the Construction Division at the Walla Walla (Wash.) District of the Corps of Engineers.

Charles D. Curran, senior specialist in engineering and public works for the Legislative Reference Service, Library of Congress, has been designated special staff

director on the investigations to be conducted by the Special Subcommittee to Study Civil Works Projects, House Committee on Public Works. The subcommittee will study policies, practices, and procedures in connection with the authorization and construction of river and harbor and flood control projects.

Charles A. Bissell, since 1944 regional engineer in charge of the Design and Construction Division of the Bureau of Reclamation, at Boulder City, Nev., has retired after 34 years of government service. As regional engineer, Mr. Bissell has provided technical direction and supervision for the construction of Davis Dam on the Colorado River, over 1,500 miles of transmission lines and attendant facilities, and the Coachella Division of the All-American Canal System. Recently he was awarded a promotional increase in salary for his "extraordinary efficiency."

Charles A. Bissell

George T. Treadwell, previously chief engineer for the Port of Seattle, Wash., has been promoted to general manager and chief engineer.

David A. Morris, colonel, Corps of Engineers and for 30 years a commissioned officer, has been named commandant and professor of military science and tactics at Carnegie Institute of Technology.

Robert B. Rothschild, Jr., Bennett L. Raffin, and **L. Don Weirick** have formed a partnership under the firm name of Rothschild, Raffin & Weirick (successor firm to Haas & Rothschild), with headquarters at 274 Brannan Street, San Francisco, Calif.

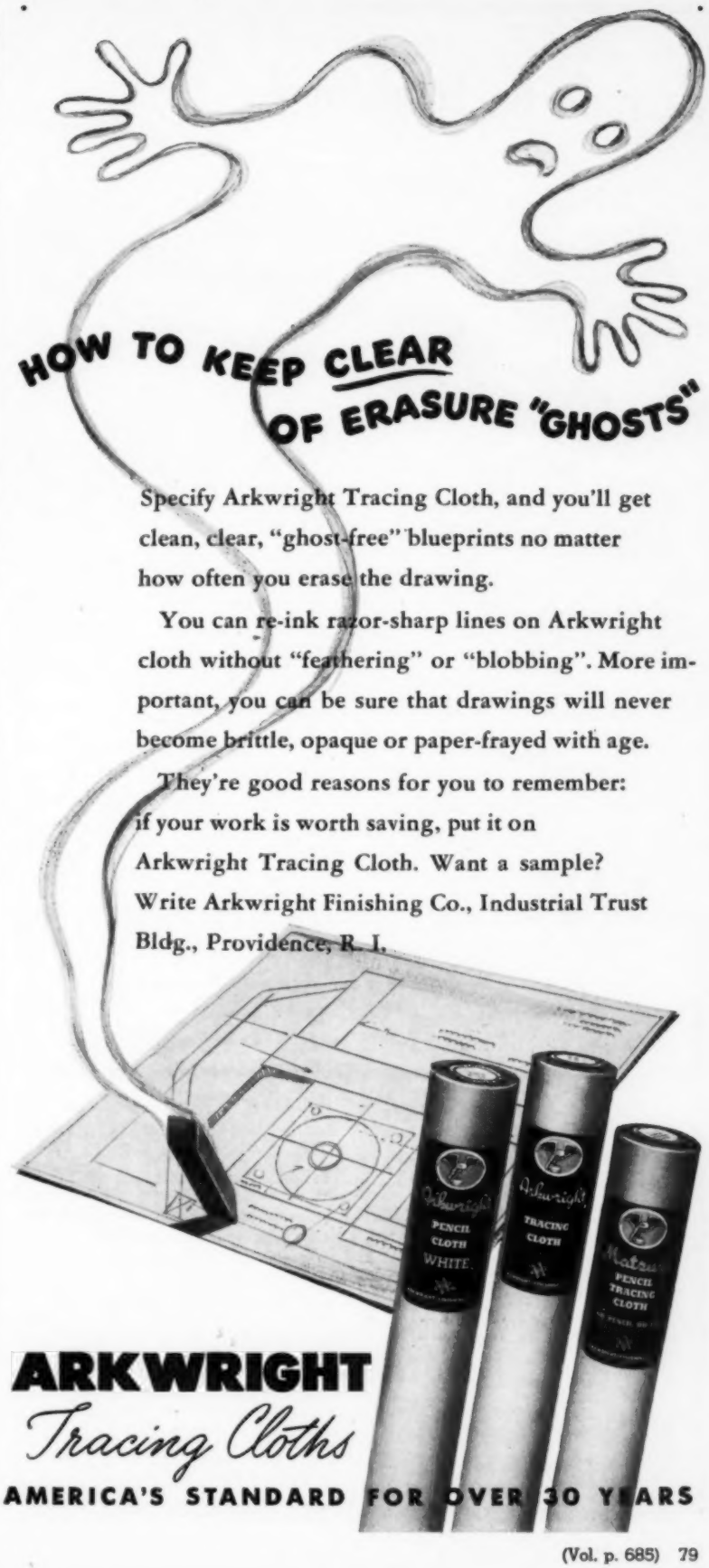
Howard L. Furr, formerly associated with Sverdrup & Parcel, in St. Louis, Mo., has joined the civil engineering faculty at the University of Mississippi, where he will have charge of all courses in the field of mechanics.

Richard A. Hertzler has been appointed to the technical staff of the Secretary of Agriculture, Washington, D.C., as flood control survey officer. Formerly he was chief of research in wood utilization at the Southeastern Forest Experiment Station, at Asheville, N.C.

W. F. M. Longwell, previously professor of civil engineering at Worcester Polytechnic Institute, is now structural analyst and principal assistant to the vice-president in charge of testing and inspection for the Thompson & Lichtner Co., Inc., Engineers, of Brookline, Mass.

Frank Bromilow, since 1948 associate professor of civil engineering at the University of Florida, has accepted appointment to the position of professor and head of the department of civil engineering at

(*Continued on page 80*)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News of Engineers

(*Continued from page 79*)

New Mexico A. & M. College. Previously he was chief engineer for the Plasteel Corp., in Washington, D.C

Robert F. Blanks, until recently chief of the Research and Geology Division of the U.S. Bureau of Reclamation, at Denver, Colo., has joined the Ideal Cement Co. of Denver, as vice-president and general manager of Great Western Aggregates, Inc., a subsidiary of the company.

Giles G. Green, assistant professor of civil engineering at Cooper Union, New York City, is on leave of absence while serving as a major in the U.S. Air Force at March Field, Riverside, Calif.

Leo J. Ritter, Jr., is on leave of absence from his duties as associate professor of highway engineering at the University of Florida to accept a Fulbright Award as lecturer in highway engineering and soil mechanics at the University of the Philippines in Manila. In addition to lecturing in these fields, Professor Ritter will develop a modern soil mechanics laboratory and present extension-type short courses.

John D. M. Luttman-Johnson, structural engineer for Fay, Spofford & Thorndike, of Boston, Mass., is on leave of absence to serve as expert on transportation for the International Bank for Reconstruction and Development on a mission to Ceylon, where he will aid in drawing up a report covering the economic development of the country.

John J. Forrer, formerly maintenance engineer for the Commonwealth of Virginia Department of Highways, at Richmond, has been promoted to the newly created post of assistant chief engineer. In his new capacity he will have charge of the maintenance, secondary roads, equipment, tests, and cost analysis offices of the engineering division, and the clearance of all requests for research projects originating in the department.

John J. Forrer

Gordon Hamilton announces that offices of the Gordon Hamilton Contracting Co., Inc., have been moved to 505 Waldheim Building, 6 East 11 Street, Kansas City, Mo.

Maurice D. Glessner has retired as construction engineer from the Corps of Engineers, at Sacramento, Calif. Mr. Glessner started his government service with the U.S. Geological Survey in 1907 in Sacramento and since then has served other agencies throughout the United States, Alaska, Canada, Mexico, and Central and South America.

Nathan Cherniack, transportation economist for the Port of New York Authority, was recently elected president of the Institute of Traffic Engineers at the organization's 22nd annual meeting in Los Angeles.

John R. Thoman, senior assistant sanitary

engineer for the U.S. Public Health Service, in Cincinnati, Ohio, has been assigned by the USPHS to the U.S. Bureau of Public Roads project for the Ethiopian Imperial Highway Authority in Addis Ababa for a two-year period.

John H. Carruth, colonel, Corps of Engineers (retired), of San Antonio, Tex., is now principal of the Armed Services Preparatory School of that city. Colonel Carruth is co-founder of the school, which prepares young men for examinations, both competitive and entrance, for the United States military and naval academies.

Ernest F. Tippetts, Robert W. Abbett, Gerald T. McCarthy, and **William Z. Lidicker,** partners in the Knappen Tippetts Abbett Engineering Co., announce a change in the name of the firm to Knappen-Tippetts-Abbett-McCarthy, Engineers, and the admission to partnership of **James H. Stratton.**

R. N. Zack, until recently staff engineer for the Iowa Natural Resources Council, at Des Moines, has become assistant secretary of the Associated General Contractors of Iowa.

William F. Lytle, instructor in agricultural engineering at the University of Illinois, has been called to active duty in the Army. Captain Lytle is now stationed at Truax Field, Madison, Wis., as commanding officer of the weather unit.

P. H. McGauhey, until recently professor and head of the civil engineering department at Virginia Polytechnic Institute, is now in charge of the University of California sanitary engineering research projects at Richmond, Calif. He taught at V.P.I. from 1927 to 1951 with the exception of two years on leave to the University of Southern California, where he reorganized the Sanitary Engineering Division. Professor McGauhey will be succeeded as head of the civil engineering department by **Prof. Russell C. Brinker,** who has taught at the University of Minnesota, the University of Hawaii, the University of Southern California, and Worcester Polytechnic Institute. Other changes in the V.P.I. staff include the return of **Prof. W. W. Payne** to the civil engineering department after a year in graduate work at the University of Maryland, and promotion of **L. G. Rich** to the rank of associate professor of civil engineering in charge of the sanitary division.

Gordon M. Fair, Gordon McKay Professor of Sanitary Engineering and Abbott and James Lawrence Professor of Engineering at Harvard University, has been awarded the honorary doctor of engineering degree by by the Technical University of Stuttgart. The presentation was made by West Germany's chief diplomat in the United States in recent ceremonies at Harvard. The degree was given in recognition of his achievements in the sanitary engineering field and for "scientific promotion of the construction of water works."

Charles H. Blackman, chief engineer for the Louisville & Nashville Railroad, at Louisville, Ky., has retired after more than 50 years of service.

Ford Richardson, Jr. has been transferred from the Norfolk, Va., District of the Corps of Engineers to the Construction Division, Directorate of Installations Headquarters, U.S. Air Force, Washington, D.C.

W. C. Schoeller, Dallas, Tex., consultant, has accepted appointment to the position of head of the civil engineering department at Lamar State College of Technology, Beaumont, Tex.

Joseph F. Kunesh, formerly dean of the University of Hawaii College of Applied Science, is now associated with the Water Resources Division of the National Production Administration in Washington, D.C.

Eugene M. Johnson has been named acting bridge engineer for the Mississippi State Highway Department, at Jackson. Previously he was assistant bridge engineering

ASCE members with the New York firm of Knappen-Tippetts-Abbett-McCarthy, Engineers engaged in reclamation work in Greece include **Charles F. Travis,** head of investigations and construction designs for reclamation projects; **Paillip Z. Kirpich,** assistant project manager in charge of master plan reports; **James B. Ward,** geologist; **Forrest Varney,** irrigation engineer; **Edmund J. Zegarra,** soils engineers; **Lewis Levine,** adviser on bridge design to the Greek Ministry of Public Works; **Clarence N. Morang,** hydraulic engineer; **John W. Blue,** office engineer; **David S. Belknap** flood control engineer; and **Norris Matthews,** specifications engineer.

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Meetings and Conferences

American Society of Mechanical Engineers. Headquarters for the annual meeting of the American Society of Mechanical Engineers will be the Chalfonte-Haddon Hall Hotel, in Atlantic City, N.J., November 26–30.

Fifth Annual Conference of the County Engineers of Iowa. Sponsored jointly by Iowa State College, the Iowa Highway Commission, and the County Engineers Association of Iowa, the Fifth Annual Conference of County Engineers of Iowa will be held at Memorial Union, Iowa State College, in Ames, December 5–7.

National Warm Air Heating and Air Conditioning Association. The annual convention of the National Warm Air Heating and Air Conditioning Association is scheduled for the Hotel Cleveland, Cleveland, Ohio, on December 5 and 6.

Society of Naval Architects and Marine Engineers. A varied program is planned for the 59th annual meeting of the Society of Naval Architects and Marine Engineers at the Waldorf-Astoria in New York City, November 14–17.

Wire Reinforcement Institute. Headquarters for the annual fall meeting of the Wire Reinforcement Institute will be the Edgewater-Gulf Hotel in Biloxi, Miss., November 15 through 17.

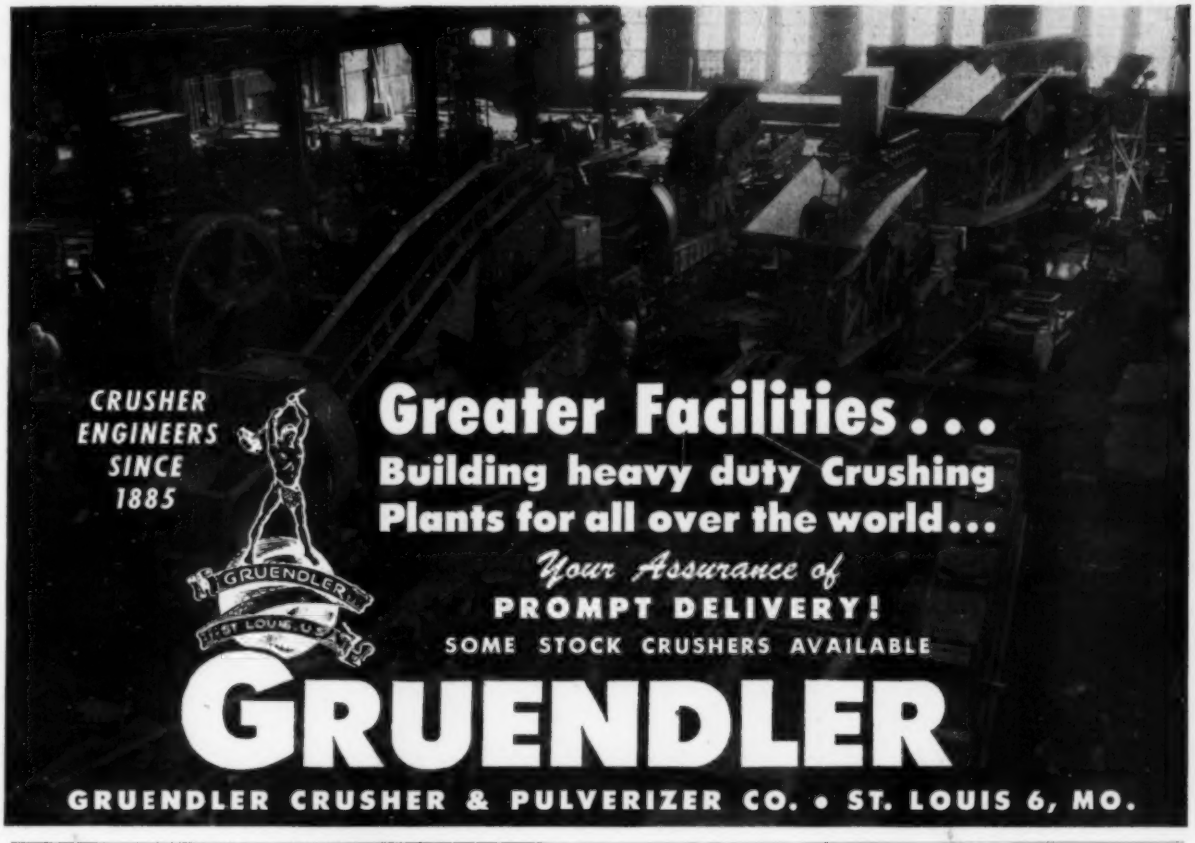
Positions Announced

Hebrew Institute of Technology, Haifa. Several positions are available on the civil engineering staff of Hebrew Institute of Technology. These include associate professors of civil engineering (buildings and structures, public works, and hydraulic engineering) and professor or associate professor of architecture or town planning. Applications, together with copies of testimonials, should be submitted before December 31, 1951, to the Secretary for Academic Staff, Hebrew Institute of Technology, Haifa, Israel.

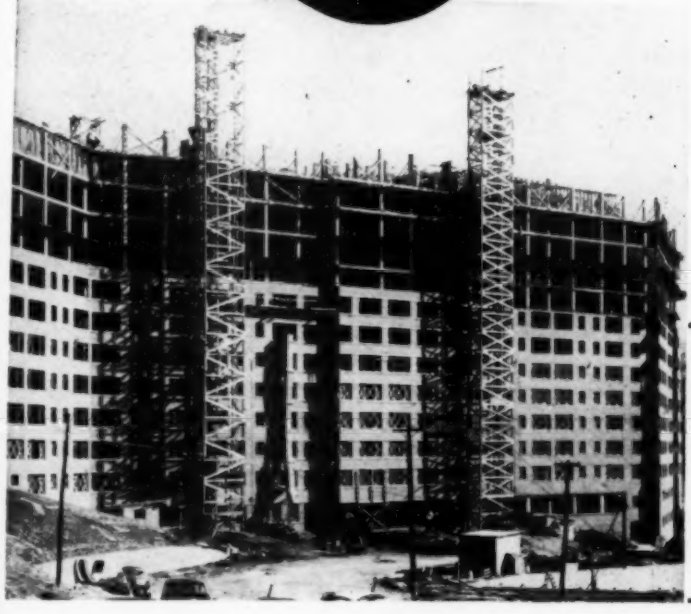
Flood Control District of Los Angeles County, California. The Flood Control District of Los Angeles County, California, is seeking a civil engineer (testing), at a monthly salary ranging from $545–$608. He will head the testing division, which is concerned with all physical and chemical testing of engineering materials, soils and water for county flood control construction and maintenance work. To qualify, applicant must be a college graduate and registered professional engineer with three years' experience, including one year in the testing field. Full information and application forms may be secured from the Los Angeles County Civil Service Commission, 501 North Main Street, Los Angeles 12, Calif.

Department of the Army. Announce-

(*Continued on page 84*)



For Concrete Construction... SOLVAY Calcium Chloride STEPS UP COLD WEATHER SCHEDULES — REDUCES COST



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Men Available

CIVIL ENGINEER; Assoc. M. ASCE; 38; capable of taking complete charge of administration, design, construction of townsite and industrial developments or extensions including planning, drainage, sewerage, water supply, hydro distribution, street lighting, roads, and buildings. Qualifications include 14 years' experience in Canada and abroad, C.E., Toronto, Registered Professional Engineer. C-704.

CIVIL ENGINEER; Assoc. M. ASCE; registered three states; C.E. degree; 42, married; 17 years' experience in industrial plant planning, layout, design, and supervision of construction, institutional building design, estimating and specifications; plant engineer's office; office supervision and management. Prefer South or Midwest. C-705.

HIGHWAY DESIGN ENGINEER; Jun. M. ASCE; 29, married; B.S. in C.E., June 1949; 2 years' experience with U.S. Forest Service (GS-7) on field and office location and construction surveys, estimates and highway design. Desires responsible position in highway engineering. C-706-5110-A-1-San Francisco.

Positions Available

ASSISTANT EDITOR with writing interest and ability, and some design experience. Should have some practical experience in design and be familiar with the method of operation of an engineering organization. Should be able to obtain and organize information from various sources into articles of practical value to engineers. Work includes traveling in quest of editorial material, visiting plants, and attending engineering conventions and expositions. Prefer resident in the vicinity of Cleveland, Ohio. Salary open. Y-5411.

CIVIL ENGINEER, graduate, with at least 3 years' experience in training or teaching military or civilian personnel, covering operation and maintenance of water, sewage, heating, and electrical facilities, to plan courses, etc., for training engineer-specialists in various phases of engineering. Appointment for 2 years. Salary, $5,400 a year; living quarters provided. Location, Europe. Y-5959.

CIVIL OR STRUCTURAL ENGINEER experienced in design and detailing of simple steel structures, preparation of job cost estimates, and plant supervision. Location, Alabama. Y-5984.

CIVIL OR MINING ENGINEER, 30-40, graduate, with some experience in road building and construction for field work. Knowledge of Spanish essential. Location, Caribbean area. Y-6000.

ENGINEERS. (*a*) Field Engineers, civil, with 2 to 5 years' experience in the field on heavy construction. Experience in hydroelectric power station helpful. (*b*) Technicians, civil graduates, preferably with experience in soil mechanics and concrete. (*c*) Resident Geologist for general observation work on large dam construction. Salaries open. Location, State of Washington. Y-6066.

STRUCTURAL ENGINEER with 10 to 15 years' experience in reinforced concrete and structural steel design for electric utility work. Location, eastern Pennsylvania. Y-6079.

GRADUATE CIVIL ENGINEERS, to 30, to train for sales position with old well-established construction machinery manufacturer. Territories open in central and western states. Splendid opportunity for advancement. Apply by letter giving age, experience, salary expected, business and character references. Headquarters, Ohio. Y-6083.

ASSISTANT EDITOR for engineering society journal. Civil engineering graduate preferred with an aptitude for writing and editing technical literature. Salary, to start, $3,600-$4,000 a year, depending upon education and experience. Location, Michigan. Y-6094.

SANITARY ENGINEER, young, with 3 to 5 years' experience handling waste-disposal problems in industry, or with municipal background. Salary, $4,200-$5,400 a year. Location, Pennsylvania. Y-6099.

FIELD CONSTRUCTION SUPERVISOR, architect or architectural engineer with some experience in building construction. Extensive traveling involved. Salary, to start, $4,200 a year and expense allowance; higher for man with more experience. Y-6119(*a*).

SANITARY ENGINEERS, 35-40, to design and draw up sewage systems and treating plants, etc., with knowledge of water producing and distribution. Should have about 10 years' practical experience in addition to a degree in sanitary engineering. Location, Virginia. Y-6120.

ASSISTANT DIRECTOR OF PUBLIC WORKS, civil graduate, registered engineer or eligibility for a certificate of registration as professional engineer for State of Maine, to assist in public works functions including street and sidewalk construction and maintenance, sewers, parks, rubbish collection and disposal, automotive maintenance, operation of gravel pit and asphalt plant, and the design, construction and alteration of building and miscellaneous structures. Should have considerable experience in the above type of work, including supervisory experience in municipal engineering work. Salary, about $5,000 a year to start. Location, Maine. Y-6128.

ENGINEER OF SANITATION, 35-50, to take responsibility for administrative engineering work in health and sanitation division of public works department. Salary, $5,334-$6,366 a year. Location, New England. Y-6186.

STRUCTURAL DESIGNER WANTED

C.E. graduate major in structural design with 3 to 5 years' experience in design of steel and reinforced concrete structures and in general drafting room procedures. Experience in structural design in oil refinery or chemical industry desired.

Location Chicago. Salary up to $7200.

Box C. E. 201
Civil Engineering
33 West 39th St.
New York 18, N. Y.

Positions Announced

(*Continued from page 82*)

ment of engineering opportunities in Alaska, Puerto Rico, Japan, Okinawa, Germany, and Austria, is made by the Department of the Army. Positions include engineering draftsman, at $3,100–$3,450 per year; civil engineers, at $3,100–$6,400 per year; hydraulic engineers, at $3,825–$4,600 per year; structural engineers, at $3,100–$4,600 per year; construction management engineers, at $3,825–$7,600 per year; and others. Complete information may be obtained from the New York District of the Corps of Engineers, Department of the Army, 80 Lafayette Street, New York, N.Y., Attention: Mrs. Sternlicht, Personnel Branch.

City of Bangor, Me. The City of Bangor, Me., is seeking applicants for the job of Assistant Director of Public Works, with a starting yearly salary of $5,000. Applicants must be graduate civil engineers with considerable experience and knowledge of public works administrative practices and techniques. Forms for application may be obtained from the City Manager, Bangor, Me.

U.S. Civil Service Commission, California. Several civil engineering vacancies exist in the office of the Forest Service in California. These include road construction and highway and bridge design positions under Grade GS-5, at $3,100 per annum; GS-7, at $3,825 per annum; and GS-9, at $4,600 per annum. Minimum requirements are a degree from an accredited college or university or the equivalent in experience and one year of specialized experience. Address inquiries to the Forest Service, 630 Sansome Street, San Francisco 11, Calif.

Mobile's City Hall, a fine example of French colonial architecture, as it looked 100 years ago

The City of Mobile in Alabama has been under four flags since it was founded in 1702 as the capitol of the French province of Louisiana. As one of our older cities, Mobile quite naturally has cast iron water and gas mains in service that were laid well over a century ago. Thanks to the shock-strength, crushing-strength and beam-strength of cast iron pipe, these old mains continue to cope with stresses undreamed-of when they were installed. And because of these strength-factors of long life cast iron water and gas mains, laid over a century ago, are still serving in the streets of more than 30 American cities.

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New Publications

Ohio River Pollution. Bacterial-quality objectives, adopted by the Ohio River Valley Water Sanitation Commission in April 1951 as a guide for evaluation of the sanitary condition of waters for potable supplies and recreational uses, are set forth in a recent booklet issued by the Commission. Inquiries concerning the publication—prepared by Harold W. Streeter, M. ASCE, consultant to the Commission, and entitled *Bacterial-Quality Objectives for the Ohio River*—should be sent to the Commission, 414 Walnut Street, Cincinnati 2, Ohio.

Hydraulic Research. A joint study of the capacity of box inlet drop spillways under free and submerged flow conditions is reported by Fred W. Blaisdell, Assoc. M. ASCE, and Charles A. Donnelly, hydraulic engineers for the U.S. Soil Conservation Service, in Technical Paper No. 7, Series B, of the St. Anthony Falls Hydraulic Laboratory. Cooperating groups were the Soil Conservation Service, the Minnesota Agricultural Experiment Station, and the St. Anthony Falls Hydraulic Laboratory. An investigation of hydraulic design of the box inlet drop spillway, by the same agencies, is also reported by Messrs. Blaisdell and Donnelly in Technical Paper No. 8, Series B. Technical Paper No. 7 sells for 50 cents and Technical Paper No. 8 for 80 cents, upon application to the Laboratory at the University of Minnesota, Minneapolis, Minn.

Civil Defense Shelter Program. A formula to judge building safety under atomic attack, devised by the Federal Civil Defense Administration, has been issued by the FCDA in a 57-page photo-offset publication entitled *Shelter from Atomic Attack in Existing Buildings*. Pointing out the cost in time, manpower, and materials of attempting to construct adequate shelters, the present manual advocates utilization of existing structures as a more practical and immediate method of providing shelters and deals with ways of utilizing them for such purposes. Material sources include criteria for the selection of shelter areas, established by the Lehigh University Institute of Research under a contract with the Office of the Chief of Engineers acting for FCDA, and standards for determining "normal peak" populations formulated by the Bureau of the Census. Succeeding manuals in the series will cover home and communal-type shelters. Inquiries should be addressed to the Federal Civil Defense Administration, Washington, D.C.

Steel Making. A comprehensive summary of present-day theory and practice in all phases of iron and steel production from raw materials to finished products comprises the sixth edition of *The Making, Shaping and Treating of Steel*, issued by the United States Steel Company. Orders for the 1,435-page text, accompanied by check or money order payable to the United States Steel Company, should be sent direct to the Treasurer, 525 William Penn Place, Pittsburgh 30, Pa.

Coastal Engineering. Availability of the Proceedings of the First Conference on Coastal Engineering, held at Long Beach, Calif., is announced by the sponsoring organization, the Council on Wave Research of the Engineering Foundation. The publication consists of 35 chapters covering basic principles of wave motion; basic design data; coastal sediment problems; site criteria and the design and construction of coastal works; and case histories. Copies sell for $4.50 plus 3 percent sales tax in California. Checks should be made payable to J. W. Johnson, 244 Hesse Hall, University of California, Berkeley 4, Calif. Formation of the Council on Wave Research was sponsored by the Hydraulics Division of the Society.

Greek Technical Dictionary. A new Dictionary of *Technical Terms in Four Languages*—compiled by G. A. Halkiopulos, Assoc. M. ASCE, director of the Technical Chamber of Greece, and listing technical terms in Greek, English, French, and German—will aid engineers and others going to Greece on technical assignments. Inquiries concerning the 886-page, cloth-bound volume should be addressed to the Technical Chamber of Greece, 4 Kolokotroni Street, Athens, Greece. The price is 150 drachmes ($15) postpaid.

(*Continued on page 88*)

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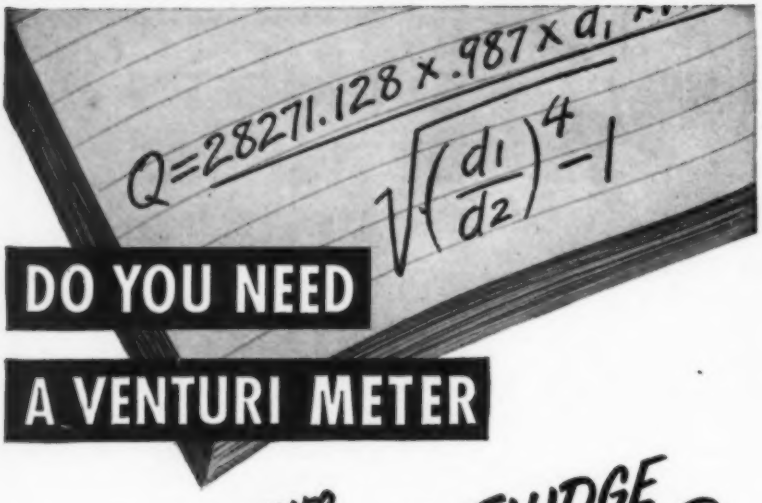

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New Publications

(*Continued from page 86*)

Technical Dictionary on Dams. Publication of the first edition of its technical illustrated dictionary on dams is announced by the International Commission on Large Dams of the World Power Conference. Languages included are French, English (British and American versions), and German. Originally intended for publication in 1940, the publication has been brought up to date since the war. Collaborators in the United States were Prof. Glennon Gilboy, Assoc. M. ASCE, and George R. Clemens, M. ASCE. The price is $3 prepaid, and all sales will be handled by the U.S. Commission on Large Dams, International Commission on Large Dams, 4316 Van Buren Street, University Park, Hyattsville, Md.

Building Code. A new Building Code of the American Concrete Institute, entitled *Building Code Requirements for Reinforced Concrete (ACI 318-51)*, allows for improved properties of new-style deformed reinforcing bars, resulting in steel savings in reinforced concrete construction. Copies of the code, which was adopted as an ACI Standard at its 47th annual convention in February, are available from the headquarters of the ACI, 18263 W. McNichols Road, Detroit 19, Mich. The price is 50 cents.

Earthquake-Resistant Construction. Recommendations for earthquake-resistant design of buildings, structures, and tank towers are outlined for the information of West Coast engineers and architects in a recent pamphlet issued by the Pacific Fire Rating Bureau. The pamphlet is intended as a supplement to and explanation of the Earthquake Tariff of the Pacific Fire Rating Bureau, and is for use of those who, in designing new buildings and structures, wish to take advantage of the special rate provisions in the Bureau's Earthquake Tariff. Inquiries should be addressed to the Pacific Fire Rating Bureau, 465 California Street, San Francisco, Calif.

Highway Research. Recent publications of the Highway Research Board include Bulletin No. 36 on *Pavement Marking*; Bulletin No. 37 on *Roughness and Skid Resistance*; and Research Report No. 13-B on *Scour Around Bridges*. Also available is Annotated Bibliography No. 9 on *Resistance of Bituminous Materials to Deterioration Caused by Physical and Chemical Changes*. Research Report No. 13-B sells for 45 cents, and Bibliography No. 9 for 75 cents. Inquiries should be sent to the Highway Research Board, Washington 25, D.C.

Sewage Treatment. Construction of sewage- and waste-treatment projects, estimated to cost $149,000,000, is recommended at 677 municipal and industrial locations in the Missouri River Drainage Basin to bring water pollution under control in a ten-state area. These recommendations are contained in a cooperative state-federal report on water pollution in the area, issued as U.S. Public Health Service Publication No. 78 under the title, *Missouri River Drainage Basin*. Inquiries concerning the report, which is one of a series on the major drainage basins of the country being prepared under authority of the Water Pollution Control Act of 1948, should be addressed to the Federal Security Agency, Public Health Service, Washington, D.C.

Watershed Management. The effects of vegetative cover on water yield are discussed by Leon Lassen, M. ASCE, Howard W. Lull, and Bernard Frank in a recent U.S. Forest Service publication entitled *Some Fundamental Plant-Soil-Water Relations in Watershed Management*. A limited number of copies is available for general distribution from the U.S. Department of Agriculture, Forest Service, Division of Forest Influences, Washington, D.C.

Surface Water, Ohio. In response to widespread demand for information on the chemical quality of Ohio streams, the Ohio Division of Water has prepared a compilation of the chemical analyses of surface waters made to date by the Division of Water and the Ohio Water Resources Board. Issued as Bulletin 23, under the title *Chemical Character of Surface Waters of Ohio, 1946–1950*, the compilation continues the long-range study of Ohio water resources being conducted by the Division of Water in cooperation with the Water Resources Division of the U.S. Geological Survey. Inquiries should be addressed to the Ohio Department of Natural Resources, Division of Water, Columbus, Ohio.

(*Continued on page 90*)

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New Publications

(*Continued from page 88*)

Technical Publishing. To aid authors of its publications in preparing technical material for the press the University of Illinois has prepared a summary of its requirements that will be helpful to other technical writers, too. A revision and enlargement of *Preparation of Manuscript*, published fifteen years ago by the Engineering Experiment Station, the present manual is issued as Engineering Experiment Station Circular Series No. 62. Copies selling for 60 cents may be obtained from the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Hydraulic Research. Issuance of a study of hydraulic models as an aid to the development of design criteria is announced by the Waterways Experiment Station. The study—prepared by Frederick R. Brown, M. ASCE, and originally presented before a meeting of the ASCE Hydraulics Division at Jackson, Miss., in November 1950—comprises Station Bulletin No. 37. Copies may be purchased for 50 cents from the Waterways Experiment Station, Vicksburg, Miss.

Aggregate Grading. Availability of a publication entitled *The Law of Grading for Concrete Aggregates*, which is directed toward clarifying the influence of aggregate grading upon concrete control in order to save material and labor, is announced by the Melbourne (Australia) Technical College Press. The publication consists of two papers by L. Boyd Mercer, M. ASCE, of Melbourne, presented before the Institution of Engineers' Conference and the Australian and New Zealand Association for the Advancement of Science Congress in Brisbane last spring. A limited number of copies can be made available to members, upon application to the Melbourne Technical College Press, Melbourne, Australia.

British Practice Codes. The Civil Engineering Codes of Practice Joint Committee of the Institution of Civil Engineers has issued two bulletins —No. 1 (1950), *Site Investigations*, and No. 5 (1950), *Drainage-Sewerage*. Copies can be obtained from the Canadian Standards Association, National Research Building, Ottawa, Canada.

Wood Research. The efficiency of using helically threaded flooring nails rather than plain shank flooring brads or cut flooring nails is demonstrated by tests described by E. George Stern in Engineering Experiment Station Series No. 78, a Bulletin of the Virginia Polytechnic Institute. Copies may be obtained for 20 cents each by writing to the Engineering Experiment Station, Virginia Polytechnic Institute, Blacksburg, Va.

Construction Equipment. Requirements for tilting and nontilting types of construction mixers, for paving mixers in a wide range of sizes, as well as safety requirements, and definitions and nomenclature of useful terms, are covered in *Concrete Mixers, Commercial Standard CS164E-50*. Printed copies of this standard may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C., at 10 cents each. A discount of 25 percent will be allowed on orders of 100 or more copies to a single address.

Hydraulic Research. The behavior of channels is described by T. Blench in *Hydraulics of Sediment-Bearing Canals and Rivers*. It covers a boundary phenomenon ignored in conventional texts—that of a boundary formed by differentiation of transported material from a water-sediment complex. The material is based on knowledge acquired from the irrigation systems built in India. Copies may be purchased from T. Blench, Associate Professor of Civil Engineering, University of Alberta, Edmonton, Alberta, Canada, for $4.75 each.

Water Pollution. In the recently issued *Report of the Interstate Sanitation Commission for 1950*, the status of the pollution program for the states of New York, New Jersey, and Connecticut is described. Inquires should be sent to the Interstate Sanitation Commission, 110 William Street, New York 7, N.Y.

Wayne County, Michigan. Activities relating to the expansion, maintenance and operation of the Detroit-Wayne Major Airport, the Wayne County park and sewerage system, and the Metropolitan water supply system are described in the *44th Annual Report of the Board of County Road Commissioners for* 1950. Further information may be obtained by writing to the Board of County Road Commissioners, Wayne County, Detroit, Mich.

RECENT BOOKS

Advanced Strength of Materials

An advanced text, by D. A. R. Clark, to follow his previous "Materials and Structures," this book covers direct stress and strain and specialized stress situations in various structural members such as beams, struts, plates, etc. Separate chapters are devoted to thick cylinders subjected to fluid pressure and to the vibrations and whirling of shafts. (Blackie & Son Ltd., London and Glasgow, 1951. 342 pages, 35*s*.)

Bemessungsverfahren, Zahlentafeln und Zahlenbeispiele

Design recommendations in the form of tables and examples for the use of reinforced concrete in building construction are provided in this book by B. Löser. The strength and characteristics of the various types of reinforced concrete sections are evaluated. Such problems as roof loads, bending moments, shear stresses, and torsion in simple and continuous beams are considered. Thirty-seven numerical examples illustrate various applications of structures employing reinforced-concrete sections. (Verlag von Wilhelm Ernst & Sohn, Berlin, 1951. 300 pages, linen, 18 *D.M.*: paper, 15 *D.M.*)

Beton-Kalender 1951, XL. Jahrgang

This comprehensive two-volume handbook on concrete and reinforced-concrete construction covers the whole range from the basic mathematics through structural analysis and the characteristics and properties of materials to an extensive treatment of the design of various structures. Applicable German standards are cited and in many cases reproduced. (Verlag von Wilhelm Ernst & Sohn, Berlin, 1951. Part I, 656 pages, cloth; Part II, 400 pages, 16 *D.M.* per set.)

The Conservation of Ground Water

This book, by H. E. Thomas, is the result of a survey and analysis of the available information on the present development and use of ground water in the United States. It reviews basic hydrologic principles; outlines an inventory of our total water resources; and discusses the experience of over 70 areas (in 35 States) in ground-water development, distinguishing the main types of ground-water problems, and describing the measures which have been or could be taken to improve the situation. (McGraw-Hill Book Co., New York, Toronto, London, 1951. 327 pages, $5.)

Forschungshefte aus dem Gebiete des Stahlbaues, Heft 7. Über den Einfluss hochfester Stähle auf Gewichtsersparnis und Bauart im Stahlbrückenbau

Based on the experience of the author, O. Erdmann, *Forschungshefte aus dem Gebiete des Stahlbaues*, discusses in detail the theoretical considerations as well as the structural and design characteristics involved in the use of certain low-alloy, high-strength steels for the construction of bridges. The various structural members and also construction methods, such as welding, are considered. Numerous figures and tables illustrate the text. (Springer-Verlag, Berlin, Göttingen, Heidelberg, 1950. 83 pages, *D.M.* 10.)

Hydraulic Transients

Written for design engineers in the hydraulic and hydroelectric fields, this book, by G. R. Rich, applies arithmetic integration and trial-and-error arithmetic to the solution of a wide variety of problems in hydraulic transients. It not only furnishes a background for the arithmetic calculation of particular problems, but also provides the essential

(*Continued on page 94*)

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Fig. B-144-A

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Recent Books

(*Continued from page 91*)

mathematical foundation for the supporting theory. Important features are the integration tabulations and detailed analysis of surge tanks, and the numerical designs which can be assimilated and imitated in commercial practice. (McGraw-Hill Book Co., New York, Toronto, London, 1951. 260 pages, $6.)

Introductory Soil Mechanics and Foundations

Written by G. B. Sowers and G. F. Sowers for undergraduate civil and architectural engineering students who are not soil specialists and for practicing engineers who encounter soil problems in their everyday work, this book stresses the rational scientific approach to soil and foundation problems and explains how the theories are applicable in usual engineering situations. Prerequisites are a knowledge of basic geological principles, applied mechanics, some understanding of structural design, and an appreciation of constructional procedures. (Macmillan Co., New York, 1951. 284 pages, $4.75.)

Jahrbuch der Hafenbautechnischen Gesellschaft, Volume 19, 1941–1949.

Several short lectures and longer papers on various aspects of harbor technology are presented in this yearbook. Among the subjects covered in the lectures are the reconstruction of West German harbors and fog protection in narrow waterways. The long papers deal with the calculation and structural details of drydocks and locks, the calculation of wave impact on piers and breakwaters, the centralization and decentralization of harbor structures in channels, and the construction and operation of coal-export harbors in the Rhine-Westphalia industrial region. (Springer-Verlag, Berlin, Göttingen, Heidelberg, 1951. 235 pages, 40 *D.M.*)

Molesworth's Handbook of Engineering Formulae and Data, 34th Edition.

Edited by A. P. Thurston, this comprehensive compilation of engineering information, formulae and data has been completely revised, rewritten and expanded to conform to the current requirements of the engineering profession. Section I covering the fundamentals of mathematics, mechanics, materials, physical data, etc., is followed by Sections II, civil and general engineering, III, mechanical engineering, and IV, electrical engineering. A 50-page index provides effective access to the contained information. (E. and F. N. Spon, Ltd., London, 1951. 1672 pages, $6.50.)

SAE Handbook 1951

Completely revised and re-styled, the 1951 SAE Handbook contains technical reports, standards and recommended practices for the automotive industry. It covers materials, parts, and equipment for all kinds of motor vehicles. Separate sections deal with ferrous, nonferrous and nonmetallic materials, with common parts, with engines and electrical equipment, and with equipment for passenger cars, trucks, buses, tractors, earthmoving and marine use. (Society of Automotive Engineers, 29 West 39th Street, New York, 1951. 864 pages, $10.)

Simplified Mechanics and Strength of Materials

An elementary treatment of the fundamental principles underlying the action of forces on bodies and the resulting stresses is provided in this book by H. Parker. It is intended for those who have limited preparation as well as for those who have need of reviewing the most important of the basic principles of structural design. A feature of the book is a detailed explanation of numerous illustrative practical examples. (John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1951. 275 pages, $4.)

Soil Testing for Engineers

Filling a need for a text for the teaching of soil testing in the laboratory, this book (by T. W. Lambe) is also of value as a reference for practicing engineers and for personnel in soil laboratories. Following an introductory chapter on general laboratory procedures are chapters devoted to the individual laboratory soil tests, which are commonly

employed. Apparatus, supplies, recommended procedures, discussion of procedure, calculations, results, and numerical examples are provided for each test. Brief derivations of formulas and explanations and discussions of calibration procedures and special techniques are given in the appendix. (John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1951, 165 pages, $5.)

Symposium on the Identification and Classification of Soils

Presented at the 53rd annual meeting of ASTM in Atlantic City, N.J., June 29, 1950, this symposium describes and evaluates the most widely used procedures in current use for identifying and classifying soils for engineering purposes. Following the introductory paper, there are five papers with discussion. The first is an appraisal and statement of principles; the second, a classification proposed by the Bureau of Reclamation; the third, a discussion of the Highway Research Board's classification of highway subgrade materials; the fourth, a proposed classification for highway purposes; and the fifth a presentation of soil series names for a classification system. (Published as Special Technical Publication No. 113 by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1951. 91 pages, $1.65; to members, $1.25.)

Applications for Admission to ASCE, September 22–October 13

Applying for Member

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JAMES BINNIE FISKEN, Spokane, Wash.
PAUL JOSEPH FOEHL, Denver, Colo.
OLIVER HAZARD FOLSOM, Sacramento, Calif.
EDWARD JOHN GROSCURTH, Austin, Tex.
CHARLES JOSEPH HEIM, Omaha, Nebr.
SAMUEL HENRY HILL, New Orleans, La.
CORNELIUS WILLIAM KOOPMAN, Estado Falcon, Venezuela.
MO CHIH LI, Hong Kong, China.
EMMETT BEAUMONT MARTIN, Helena, Mont.
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ALBERT JAN OUDHEUSDEN, JR., Douglassville, Pa.
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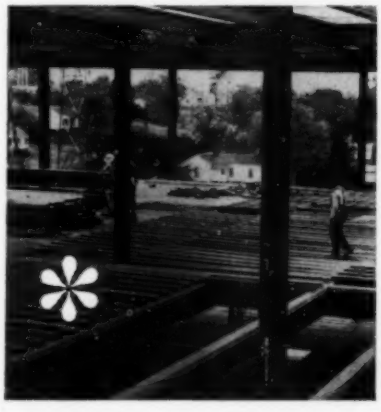

● When he placed an order for more than 580,000 board feet of Koppers Pressure-Treated Lumber, Mr. E. L. Scruggs, Vice President of the Springs Cotton Mills, expected good service. And he wasn't disappointed.

Here's what he wrote after the new addition to his plant had been completed: "We wish to tell you that this is one of the few large lumber orders that we have ever placed which was completed on time and without a single rejection. We consider the service rendered and quality of material unusually good."

Koppers makes every effort to deliver pressure-treated lumber when promised, thus doing away with costly delays in construction. And Koppers, by chemical impregnation, changes the characteristics of wood so that it will stand up under *your* particular conditions. For example, Koppers can make wood resistant to decay, termite attack, marine borers —can even make it fire-retardant if desired.

Get in touch with us. We will gladly furnish quotations on Koppers Pressure-Treated Wood.

KOPPERS COMPANY, INC., Pittsburgh 19, Pa.

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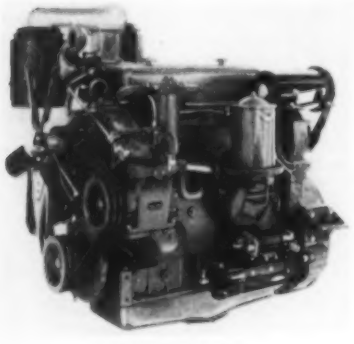
EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Diesel Engine

A RUGGED DIESEL engine with more power, amazing economy, greater performance and longer life has been introduced. Built to haul a million miles and more, the Million-Miler is a new design of the famed 4-71 and 6-71 GM diesel engines. The Million-Miler will power the GMC 650, 740, 750, 900, 950 and 970 series trucks and tractors. None of the changes will obsolete former GMC diesel engines, for the new components were especially designed to be interchangeable with the old.



Million-Miler

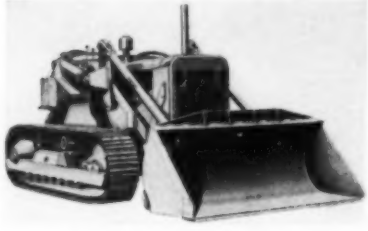
Most important factor in achieving the new fuel savings is a revolutionary device called a Fuel Modulator, an automatic control that feeds exactly the right amount of fuel and air for maximum efficiency regardless of throttle position. Acting like a mechanical "brain," the Fuel Modulator exerts its modulating effect on the flow of fuel at engine speeds below 1500 rpm. Another feature of the Million-Miler that has increased horsepower is a camshaft that keeps valves open through a greater portion of the shaft revolution, as compared to the former engines. The camshaft opens the valves longer providing freer breathing, better scavenging of the burned gases and a better change of fresh air. Whereas the Fuel Modulator cuts fuel waste below 1500 rpm, the camshaft improves fuel economy approximately six percent at engine speeds above 1500 rpm. The cylinder head and cylinder block have ground faces, allowing metal-to-metal contact without need for a cylinder head gasket. Synthetic rubber rings and strip gaskets seal water and oil openings, while a Belleville (cupped) washer type ring seats on the individual cylinder sleeve and seals the combustion chamber. Further improvements to lengthen engine life include a stronger crankshaft, a Houde viscous damper, and heavy-duty copper lead bearings for the crankshaft and connecting rods. **General Motors Corp., Truck and Coach Div., 660 South Boulevard, East, Pontiac 11, Mich.**

Underwater Pumps

THE NEW LANCASTER underwater pump has been announced. Pump and electric motor are designed to operate under water and can be set as deep as 800 ft. The pumping sets come in diameters as small as 4 in. and capacities as large as 2,000 gpm. Motor sizes range from $\frac{1}{2}$ hp to 250 hp. The underwater pump does away with all the disadvantages of older types of pumps in delivering water from deep wells. It eliminates rods, plungers, cylinders, and there are no long shafts or bearings. No priming is required and the cost of a pump house is eliminated. The underwater pumps cannot be damaged by frost, heat or dust. They are the easiest type of deep well pumps to install and require no attention after installation, inasmuch as there is no seal in either the pump or motor part. **Lancaster Pump & Mfg. Co., Inc., Lancaster, Pa.**

Shovel-Mounted Tractors

A COMPLETE LINE of shovel-mounted tractors, with standard bucket capacities up to 4 yds (light material buckets up to 7 yds) is now available in all four models of Allis-Chalmers crawler tractors. The

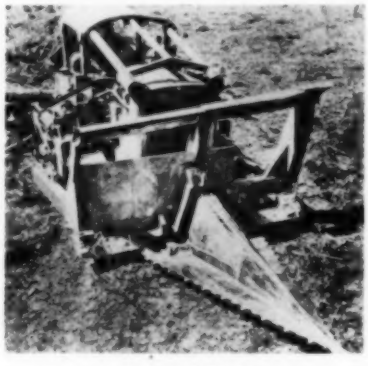


Available in Four Models

larger sized tracto-shovel units—designated as Models HD-9G, HD-15G and HD-20G—are similar in design to the 1 yd capacity HD-5G. Multi-utility machines, the complete line of tracto-shovels can be maneuvered in confined areas—are easily transported from one job to another. Varying in capacity, to match the weight and horsepower of each tractor, the HD-9G mounts a 2 yd bucket and dumps at a maximum height of 11 ft, $4\frac{1}{2}$ in. The HD-15G employs a 3 yd bucket and has a dumping height of 12 ft, 8 in. while the huge HD-20G torque converter driven tractor, uses a 4 yd bucket dumping at a height of 13 ft 5 in. A variety of interchangeable attachments including special buckets, snow plows, bulldozer blades and rock forks are available for most models. All attachments can be removed or installed in a matter of minutes by the simple removal of four pins which are easily accessible. **Allis-Chalmers Mfg. Co., Tractor Div., Milwaukee 1, Wis.**

Saw Blade

TWENTY-THOUSAND COTTONWOOD trees, 4 to 12 in. in diameter, are being salvaged by the Bureau of Reclamation at Boysen Reservoir. The salvaging of these trees, to be used in erosion control, is accomplished through a method introduced into reservoir clearing operations at Boysen Reservoir. The trees fall with a single pass of a 6 ft long "V" shaped saw blade which is attached to the bulldozer of a Cat D7 tractor. The saw blade rides



V Shaped Blade

along the cutting edge of the bulldozer blade and cuts the trees at ground level. With teeth on each side of the "snout" a single dozer can fell as many trees as that done by five chain saws and crews, clearing as much as 5 acres of dense timber during an 8 hr day. In easier going, 10 acres per 8 hr day can be cleared. Cutting of the trees is fairly simple. The dozer operator guides the saw so that it strikes the tree near the point of the cutting edge and then forces the saw through the trunk in a single pass. **Caterpillar Tractor Co., Peoria 8, Ill.**

Bending Tool

A BENDING TOOL which can be used in six different directions, has been developed. The Tal 6-way hickey with its six no slip bending jaws, makes it an ideal tool for making bends, elbows, sets, offsets, loops, saddles and stubs on open or slab work and in close quarters. The stub hole is a new feature devised for bending or straightening conduit protruding from concrete floors or walls. The long safety neck extends into the pipe handle, making this tool danger proof against accidents caused by the pipe handle breaking. The sure grip jaws are another added safety feature against the hazard of the pipe slipping during the bending operations. It is the perfect hickey for the electrician, enabling him to handle the most difficult job. **Tal Bender, Inc., Milwaukee 2, Wis.**

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Equipment, Materials & Methods (Continued)

Irrigation Canal Liner

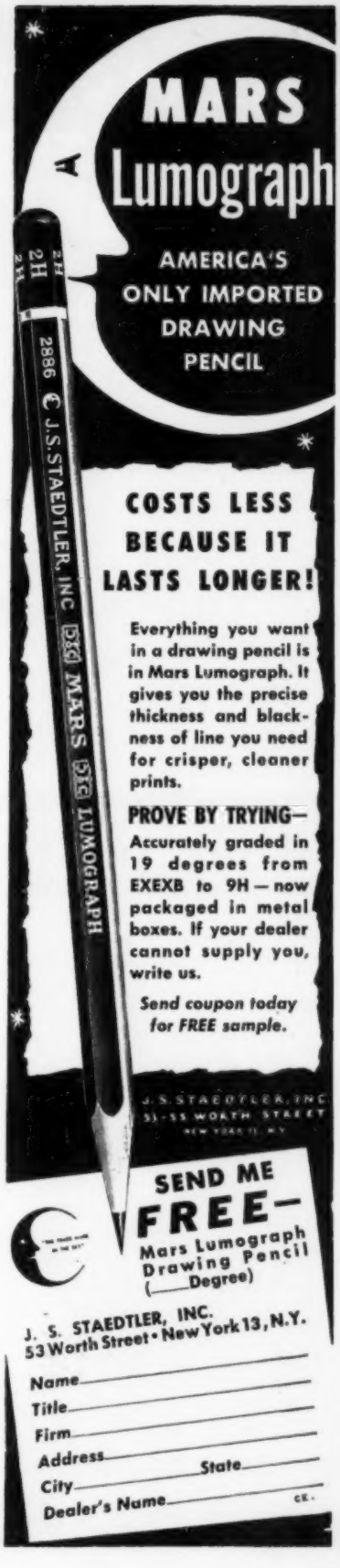
IRRIGATION CANAL LINER, a product designed to control seepage and erosion in ditches and canals, is being announced. The liner is a Fiberglas-reinforced prefabricated asphaltic membrane lining for installation on bottoms and sides of most types of canals and lateral ditches. The liner also may be used in stock and irrigation ponds and swimming pools. Fiberglas canal liner can be applied at any time during the year and can be stored indefinitely. It can be installed with hand tools and unskilled labor. Two men can install it, and a crew of four to six men can apply from 200 to 300 sq yds an hour under normal conditions. After the bottom and sides of the canal are excavated and

Controls Seepage and Erosion

smoothed, the irrigation canal liner is installed and anchored to the ground with wire staples, after which staple holes are sealed. The liner may be installed longitudinally, thereby eliminating much cutting, or laterally. Three things made the lining possible, and were responsible for its success: the fact that the same soil which is removed from the canal, as it is being smoothed and graded, can be used as a cover to hold the membrane in place; the development of special asphaltic materials which have a long life, are tough, easy to handle in cold weather, and do not soften in hot weather and; simplicity of construction. Fiberglas canal liner has a long life and is impervious to moisture and to soil acids. The liner is strong enough to resist tearing and puncturing and flexible enough to conform to the contour of the ground surface. **Owens-Corning Fiberglas Corp., Toledo 1, Ohio.**

Heavy-Duty Fenders

HEAVY-DUTY FENDERS are now standard equipment for "Cat" D8 track-type tractors. The stronger fenders are manufactured from $\frac{1}{2}$ in. steel plate and will provide a more rigid platform for mounting equipment. The heavy-duty fenders will withstand greater abuse and rough treatment sometimes encountered in pioneering and logging operations. The company anticipates that the fenders will also become standard equipment for "Cat" D7 and D6 tractors within the near future. **Caterpillar Tractor Co., Peoria, Ill.**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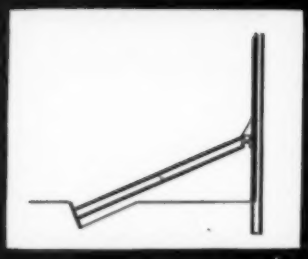

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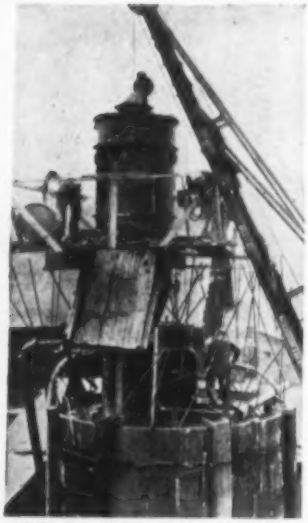

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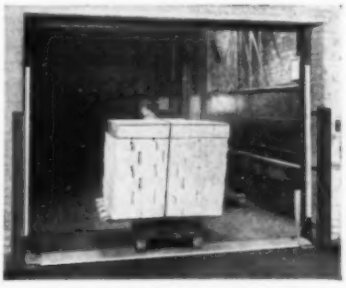
Equipment, Materials & Methods (Continued)

Elevator Sill

A LINE OF METAL sills to fit just about any kind of freight elevator now being used is on the market. They bridge the gap between elevators and floor of building, platform or motor truck. The 1951 Model E, equipped with two electric interlocks, becomes an integral part of the elevator and gives sill protection on every floor where the elevator stops. When sill is down, the elevator is locked, and can move only when the sill has been closed. When closed, it is in upright position and acts as a protective gate so that trucks and carts cannot roll off elevator while it is in motion. **Alexander Sill Company, 970 Milwaukee Ave., Chicago 22, Ill.**



Model E

Weight Slide Rule

THE MODEL NO. 1373-C Wakco weight rule is designed to enable you to determine the correct weight of any size or shape of lead, copper, brass, steel, cast iron, aluminum or magnesium in a matter of seconds. The Model C rule has been entirely redesigned and instead of the two slides as formerly used, the present rule is made of the standard Duplex type slide rule construction, with only one slide and a cursor. The rule is shorter, narrower, lighter, and much easier to operate. Accuracy is assured, not only because of the precise construction, but because the smoothness of operation of the successive movements of the cursor and slide eliminates the possibility of slipping. The Model C is no longer merely a weight rule. The scope of usefulness of the rule has been greatly increased by including on the reverse side a new arrangement of standard slide rule scales. This takes the rule out of the special rule class into the field of an all purpose slide rule. The Model C saves hours of time, by getting the right answer the first time; prevents waste; improves efficiency; and takes the guess work out of important calculations. **Warren-Knight Company, 136 North 12th St., Philadelphia 7, Pa.**

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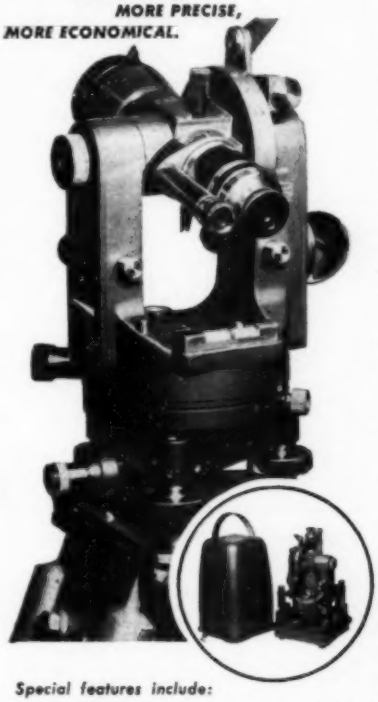

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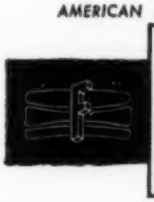

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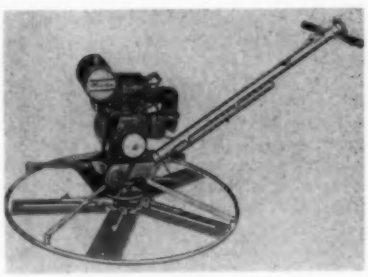
Equipment, Materials & Methods (Continued)

Graph Paper

DYLEWSKI ARKTAN arctangent coordinate graph paper is available. The use of arctangent coordinates permits the plotting of uninterrupted curves of data having values ranging from plus infinity to minus infinity and including zero as well. Most asymptotic functions become approximately linear in this coordinate system. Typical examples of applications are the plotting of reactance functions, radioactive decay curves, and heating and cooling curves. Extrapolation to zero and infinity and interpolation are easily accomplished. Free samples of the arctangent coordinate graph paper and also the Arktan Bulletin are available. **Orbit Electric Company, 2710 N. Menard Ave., Chicago 39, Ill.**

Floating and Finishing Machine

A CONCRETE FLOATING and finishing machine, known as Model C, has five rotating trowels instead of the conventional three, making it possible to move onto a wetter slab, saving valuable waiting time. It has a new type universal trowel that can be used for both floating and finishing by a simple adjustment of the pitch, eliminating the necessity of changing trowels. An adjustment on the trowel arms allows perfect alignment of trowels at all times.



Model C

As on all Whiteman models, trowel pitch can be changed while the machine is in motion by turning a knob on the end of the shaft. The handle is wider for better control and has comfortable rubber grips. A stationary guard ring encircling the machine permits finishing within $1\frac{1}{2}$ in. of walls, columns, etc. The Model C is powered by a 6 hp, 4-cycle gas engine giving it considerable power, making it especially suitable for heavy slabs. A double-groove clutch with two belts increases trowel speed 25 percent. The machine operates more easily and offers less pull to the operator. With the trowels adjusted for floating, it quickly compacts the slab, drives out air pockets, brings up moisture and produces a good surface where traction is desired. Adjusted for finishing, it produces a smooth, level surface in minimum time. **Whiteman Mfg. Co., 3249 Casitas Ave., Los Angeles 39, Calif.**

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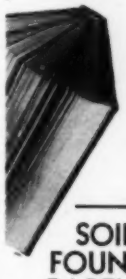

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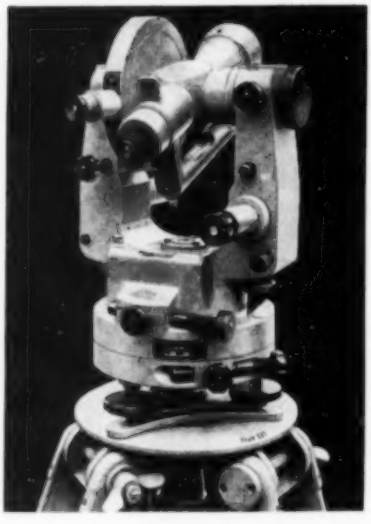
Equipment, Materials & Methods (Continued)

Precision Transit

A PRECISION TRANSIT, Model No. 30, designed for high precision surveying, is announced by the Breithaupt Company. The model incorporates the standard features of Breithaupt surveying instruments such as totally enclosed and dust proof



Model No. 30

construction, compactness and reduced weight. The instrument weighs 11½ lbs. It has a reading accuracy on vertical and horizontal circles of one second. The telescope has 40 mm aperture and 30 x magnification. The sensitivity of the instrument's three levels is 20 sec per 2 mm. Write to **Columbia Technical Corporation, 5 East 57th St., New York 22, N.Y.**

Bucket Tooth

THE DEVELOPMENT of Tap-In bucket teeth as standard equipment on all trenchliners has been announced. Principal feature of the newly designed, self-locking tooth is the "easy-in, easy-out" time saving replacement involved. Tap-In teeth eliminate the need for bolting or crimping edges to hold teeth in position. A precision fit taper locks the tooth firmly in place either on buckets or sidecutter bars. Sturdy tooth holders are integrally cast with the bucket lip for positive tooth support. By welding adapters to the buckets, trenchliners of any age can be converted to use Tap-In teeth. Made of the finest grade alloy steel and heat treated, these teeth are designed with added clearance for maximum wear before replacement becomes necessary. In addition, Tap-In teeth need not be reversed. The tooth is designed to retain a sharp point by constant use until worn down to clearance. **Parsons Company, Newton, Iowa.**

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ARC WELDS—A pocket size booklet "Hobart Welding Electrodes and Welders' Vest Pocket Guide," containing useful arc welding information, is now available. This handy booklet gives information on metals and electrodes, types of electrodes, four essentials of proper welding procedures, color marking for identification of electrodes, types of joints, typical positions, standard steel shapes, etc. **The Hobart Brothers Co., Box EW-161S, Troy, Ohio.**

REFERENCE BULLETIN—A 28-page basic reference bulletin, compiled primarily for design engineers, presents the many valuable characteristics of modern nickel cast irons and illustrates their broad acceptance throughout industry. Fifty illustrations indicate wide industrial usage in all sizes and shapes. Twenty-seven useful tables, charts and photomicrographs show how through the use of nickel, alone or in combination with other alloying elements, the engineering properties of cast iron can be controlled to meet almost any reasonable combination of service requirements. **International Nickel, Dept. EZ, New York 5, N.Y.**

CRAWLER TRACTORS—An 8-page folder just issued shows the varied applications contractors are finding for International crawler tractors in the nation's booming soil conservation and land reclamation program. Entitled, "International Power Makes Soil Saving a Pay Dirt Proposition," the folder outlines the dirt moving possibilities in the Soil Conservation Service's 20 year program to save 10,000,000 productive acres from erosion and presents conservation jobs currently in progress. Request form CR-119-A. **International Harvester Company, 180 North Michigan Ave., Chicago 1, Ill.**

EXCAVATORS—A 32-page, two-color booklet entitled, "Marion All-Purpose Excavators" features a 93-M dragline on its four-color cover, and shows working views of the entire line of Marion machines inside its covers. Starting with the Type 33-M—a $^3/_4$ cu yd standard shovel—Bulletin 403 lists condensed specifications and types of service to which the machines can be converted for use—as shovel, dragline, clamshell, crane, backhoe, pile driver, or coal loader—and crane lifting capacities. **Marion Power Shovel Company, Marion, Ohio.**

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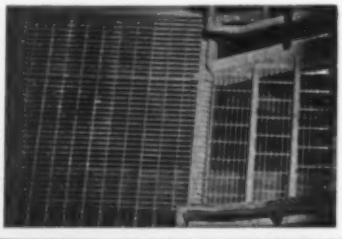

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Literature Available (Continued)

SEWER BOOKLET—Publication of a 48-page booklet entitled "Concrete Sewers" has just been announced. Designed primarily as a reference book for sanitary engineers, it contains a number of tables and charts packed with valuable information on the design and construction of concrete sewer systems. This material includes the latest available research data covering loads on sewer conduits. **Portland Cement Association, 33 West Grand Ave., Chicago 10, Ill.**

CONTROLLED VOLUME PUMPS—An illustrated, 24-page, 2-color bulletin on controlled volume pumping and Milton Roy controlled volume pumps has recently been published. The bulletin gives complete details on controlled volume pumping, describes the features that make the controlled volume pumps perform flawlessly on services where no other pump has filled the need, and includes data required for selecting pumps for specific applications. **Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pa.**

VIBRATING SCREEN CATALOG—A very complete, 20-page illustrated Book No. 2377 on Model "UP" vibrating screens for the fast, accurate dry-screening of light and fine materials and Model "NRM" liquid vibrating screens for the low-cost, high speed separation of solids from liquids, has been published. Descriptive material includes specific information on how to select the right screen and screen cloth for maximum operating efficiency; dimension tables, weights, horsepower requirements; and other data of value to the engineer and plant operator. **Link-Belt Company, 307 N. Michigan Ave., Chicago 1, Ill.**

TECHNICAL BOOKLET—A booklet on the fabrication and design of nickel and high nickel alloy pipe and tubing has been issued. Designated as Technical Bulletin T-17, it contains 27 pages illustrated throughout by drawings and photographs. It also presents tables on mechanical and physical properties, A.S.M.E. code requirements, recommended welding procedures and other information. **Development and Research Div., International Nickel Co., Inc., 67 Wall St., New York 5, N.Y.**

CABLE CONNECTIONS FOR ELECTRIC WELDING—A 12-page, No. 8 Twecolog illustrates and describes the complete line of Tweco electrode holders, ground clamps, cable connectors, terminal connectors, cable splicers, mechanical and solder type cable lugs, carbon electrode holders and the new "lug-set" block and punch for attaching solder type lugs to cables without solder. Contains information about the care and maintenance of electric welding cables and connections. **Tweco Products Company, P.O. Box 666, Wichita, Kansas.**

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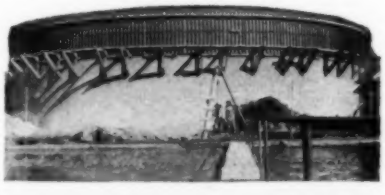

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Summarized in Earlier Issues

82. Pressures in a Shallow Rectangular Bin, by Raymond L. Moore and J. R. Shaw.

83. Waterway Traffic on the Great Lakes, by John R. Hardin.

84. Longitudinal Mixing Measured by Radioactive Tracers, by Harold A. Thomas, Jr., and Ralph S. Archibald.

85. Resinous Ion Exchanges in Water Treatment, by William W. Aultman.

86. Ground-Water Phenomena Connected with Spreading, by Paul Baumann.

Third Notice

87. Sewage Reclamation by Spreading Basin Infiltration, by Ralph Stone and William F. Garber.

88. Experimental Study of Water Flow in Annular Pipes, by W. M. Owen.

89. Deflections in Gridworks and Slabs, by Walter W. Ewell, Shigeo Okubo, and Joel I. Abrams.

D-30. Discussion of Paper, **Economic Effects of Reservoir Sedimentation,** by William E. Corfitzen.

D-40. Discussion of Paper, **Construction Technique of Passing Floods Over Earth Dams,** by Andrew Weiss.

D-34. Discussion of Paper, **Lateral Buckling of Eccentrically Loaded I-Section Columns,** by H. N. Hill and J. W. Clark.

D-38. Discussion of Paper, **Hydrology of Mexico,** by Andres García-Quintero.

D-17. Discussion of Paper, **Origin and Significance of Openwork Gravel,** by Allen S. Cary.

D-33. Discussion of Paper, **Strength of I-Beams in Combined Bending and Torsion,** by Basil Sourochnikoff.

Second Notice

90. Consumptive Use of Water by Forest and Range Vegetation, by L. R. Rich. Consumptive use of water by forest and range vegetation depends on the distribution and occurrence of precipitation, the amount of water held by the soil, and the character and type of vegetation. Under natural conditions, consumptive use can be determined by dividing the year into four periods: (1) soil moisture recharge, (2) water surplus, (3) soil moisture utilization, and (4) water deficit. The major problem in maintaining and increasing irrigation water for the West is to determine the type of vegetation that interferes least with water yields and still controls erosion and sediment. In the Southwest perennial grasses interfere least with water yields and are a better soil cover, while half-shrubs, winter annuals, and evergreen shrubs (all characteristic of deteriorated watershed vegetation) tend to reduce water yields. (Available November 1.)

91. Consumptive Use of Water, by Harry F. Blaney. In water-supply and irrigation investigations, engineers are called upon to make, within a limited time, estimates of probable past, present, and future evaporation and evapo-transpiration losses from areas in river valleys when few long-period hydrologic records, except climatological data, are available. Although evapo-transpiration has been measured at various times and places, very little data are available in most sections of the United States. This paper presents data on measured evapo-transpiration by agricultural crops and natural vegetations and discusses the subject of consumptive use of water with special reference to definitions, method, and results of research by the Division of Irrigation and Water Conservation, United States Soil Conservation Service, and other agencies. It outlines a procedure developed for computing consumptive use in areas which no measurements except climatological data are available. (Available November 1.)

92. Experimental Investigation of Fire Monitors and Nozzles, by Hunter Rouse, J. W. Howe, and D. E. Metzler. The inefficiency of fire streams is directly attributable to the initial turbulence of the free jet. This paper describes the design of a fixed monitor, a portable monitor, and a nozzle that will reduce flow turbulence to a practicable minimum. The underlying design principles are discussed and the efficiencies of existing and improved units—as determined in special testing facilities—are compared. Design details and performance curves are presented for the recommended forms. (Available November 1.)

93. Aircraft Design as Related to Airport Standards, by Milton W. Arnold. Attainment of all-weather operation, utilizing existing aircraft, present-day airports, and presently developed electronic equipment has been found to be economically prohibitive. Closer correlation should exist between aircraft design, airport design, and electronic equipment development to achieve the all-weather goal, at reasonable cost, for the convenience of the flying public. Steps toward the achievement of this goal are outlined in this paper. (Available November 1.)

94. Friendship International Airport, by Benjamin Everett Beavin. An interesting feature of the design of Friendship International Airport was the laying aside of existing (1946) notions as to airport design and going back for guidance to the fundamental needs of the various users, such as the airlines, the taxpayers, government agencies, contractors, and the most important of all, the passengers and prospective passengers. In this paper the total length of apron frontage is shown as a measure of the value received for the money spent in building an airport. The economy of construction and operation is stressed, and many desirable features of design are enumerated. (Available November 1.)

95. Directional Requirements for Airport Runways, by Ralph H. Burke and Harry Otis Wright, Jr. The benefits of airport standards are enumerated in this paper, and the reasons for their adoption are cited. It traces the history of the developments in landing gear and summarizes the effect of these develop-

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ments on increased tolerance in cross wind operations. Airport utilization with simplified runway patterns is discussed and suggestions are given as to airport design to meet present and future requirements of aviation. (Available November 1.)

96. Surface Curves for Steady Nonuniform Flow, by Robert B. Jansen.

D-36. Discussion of Paper, **Impossibility of Performance in Contracts for Engineering and Construction,** by Robert F. Borg.

D-39. Discussion of Paper, **Practical Design of Solid-Barrel Reinforced-Concrete Skew Structures,** by Bernard L. Weiner.

D-42. Discussion of Paper, **Wind-Load Standards in Europe,** by John W. T. Van Erp.

D-43. Discussion of Paper, **Settlement Correction at La Guardia Field,** by John M. Kyle.

D-44. Discussion of Paper, **The Problem of Wave Action on Earth Slopes,** by Martin A. Mason.

First Notice

97. **Consumptive Use in the Rio Grande Basin,** by Robert L. Lowry. With most of the available water in all of the streams of the southwestern United States already appropriated and used for irrigation, about the only remaining source of water for further expansion in irrigation lies in the possible conversion of present nonbeneficial uses to beneficial uses. The special case of irrigation along the Rio Grande between El Paso and Fort Quitman, Tex., shows what has been accomplished in this line along that stretch of river, and points the way to similar improvements that may be of profit to other projects. (Available December 1.)

98. **Consumptive Use of Water on Irrigated Land,** by Wayne D. Criddle. Water is consumed by growing crops through transpiration, evaporation from the vegetation and surrounding wetted soil, and in the building of plant tissue. The water so consumed is, therefore, not available in the streams for power, navigation, municipal water supplies, or irrigation purposes. Thus, a knowledge of the amount so consumed by various crops and other uses is extremely important in our planning for future development and operation of our streams. This paper gives a range in the amount of water consumed by various types of vegetation under different climatic conditions in the United States. That portion of the consumptive requirement contributed by precipitation at several western locations is indicated, together with a suggested method for determining peak rates of water use for irrigation system design purposes. (Available December 1.)

99. **Consumptive Use in Municipal and Industrial Areas,** by George B. Gleason. In order to determine a fair distribution of water rights in the Raymond Basin Area, Pasadena, Calif., a survey was conducted to determine the consumptive use of water. The results of this study are presented and the data analyzed to emphasize factors that may be of assistance in the planning and execution of similar surveys. (Available December 1.)

100. **Forced Vibrations of Continuous Beams,** by Edward Saibel and Elio D'Appolonia. The determination of the forced oscillations of a continuous beam caused by an exciting force is presented in this paper. The procedure requires only a knowledge of the eigenfunctions and eigenvalues of the beam from which all intermediate points of support have been removed (a simple beam). Solutions are found for forced oscillations and constraints are introduced in the form of undetermined multipliers. The cases of fixed and free vibrations are treated, and a numerical example is presented. (Available December 1.)

101. **Application of Highway Capacity Research,** by J. P. Buckley. Dealing with the complex problem of capacity determination for all sections of all road and street systems in an entire state requires the use of simplified methods. The development and use of comprehensive capacity charts in the Ohio highway planning survey are discussed and illustrated for the cases of two-lane rural roads, two-way city streets, and one-way city streets. Capacity data allow the engineer to be more realistic in determining corrective measures that can be employed to relieve congestion. (Available December 1.)

102. **Utilization of Ground Water in California,** by T. Russel Simpson. California is far ahead of other states in development of its ground-water resources. It also has a proportional share of the nation's ground-water problems that require water conservation for solution. The paper presents an account of current uses of ground water, segregated by major hydrographic areas of the state, and the over-all ground-water conditions of the state are appraised insofar as basic data are available. Certain areas are indicated in which further ground-water supplies may be developed, and other areas are indicated in which present draft must be reduced or additional water obtained either by local conservation or by importation. (Available December 1.)

103. **Pile Foundations for Large Towers on Permafrost,** by L. A. Nees. The development of natural resources in the far North has opened up new and unusual problems for the engineer, especially in the design of foundations and substructures. In particular, the prevalence of saturated fine-grained permanently frozen soils requires determination of strengths of such soils in their frozen state and the analysis of how a proposed structure affects their thermal regimen. This paper opens up for the engineer a perspective on the general problem by indicating the results of labortory pile tests in frozen soils and presenting a method for computing the heat transmission and designing pile foundations in frozen soils. (Available December 1.)

104. **Redesign of Major Airport Terminals,** Herbert H. Howell. The accelerated growth of air transport is already over-taxing the capacity of many airports, and developments in electronics and air traffic control offer a means of increasing capacity, providing the airport itself can accommodate the volume. Most existing airports are susceptible to redesign so that acceptance rate and capacity are increased. As a specific example, revisions to the 1944 master plan for the Lambert-St. Louis Municipal Airport based on new techniques in airport design and air traffic control are described. (Available December 1.)

105. **Principles of Highway Capacity Research,** by O. K. Normann. Highway capacity design problems are usually solved by empirical factors developed by the road builder. The results of research in highway capacity have been summarized in this paper to present some factual design data. A listing is made of the types of investigations conducted, and the factors of desired speed and practical capacity are related to the effects of various limitations. (Available December 1.)

D-37. Discussion of Paper, **Design of Prestressed Tanks,** by J. M. Crom. The original paper, published in October 1950, analyzed the principles involved in the design and construction of prestressed circular concrete tanks. Discussers are: L. J. Mensch, Herbert A. Sawyer, Jr., and J. M. Crom. (Available December 1.)

D-47. Discussion of Paper, **Operation and Maintenance of Irrigation Systems,** by Raymond A. Hill. The original paper, published in December 1950, described the problems of operation and maintenance of irrigation systems particularly in the United States. Discussers are George W. Howard, Lyman R. Flook, Jr., Rudolfo E. Ballester, Alfred R. Golzé, and Raymond A. Hill. (Available December 1.)

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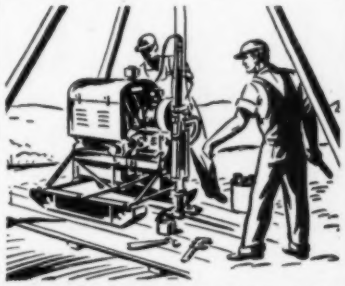

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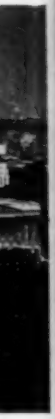

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